Table of Contents

Section 3
Fundamentals of
Bridge Inspection

Section 3

Fundamentals of Bridge Inspection

Topic 3.1 Duties of the Bridge Inspection Team

3.1.1 Introduction

Bridge inspection is playing an increasingly important role in providing a safe infrastructure for our nation. As our nation's bridges continue to age and deteriorate, an accurate and thorough assessment of each bridge's condition is critical in maintaining a dependable highway system.

There are five basic types of inspection:

- Initial (inventory)
- Routine (periodic)
- Damage
- In-depth
- Special (interim)

These are discussed in Article 3.2 of the AASHTO *Manual for Condition Evaluation of Bridges*. Although this topic is organized for "in-depth" inspections, it applies to all inspection types. However, the amount of time and effort required for performing each duty will vary with the type of inspection performed.

This section presents the duties of the bridge inspection team. It also describes how the inspection team can prepare for the inspection and some of the major inspection procedures. For some duties, the inspection program manager may be involved.

3.1.2 Duties of the Bridge Inspection Team

There are five basic duties of the bridge inspection team:

- Planning the inspection
- Preparing for the inspection
- Performing the inspection
- Preparing the report
- Identifying items for repairs and maintenance

The duties of the inspector are simply the tasks that must be performed in order to fulfill the responsibilities that come with the job.

3.1.3 Planning the Inspection

In order to make the inspection orderly and systematic, the lead inspector should make plans in advance. Planning the inspection is necessary for an efficient, cost-effective effort which will also result in a thorough and complete inspection.

Basic activities include:

- Determination of the type of inspection
- Selection of the inspection team
- Evaluation of required activities (e.g., nondestructive testing and underwater inspection)
- Development of an inspection sequence
- Establishment of a schedule

3.1.4 Preparing for the Inspection

Preparation measures needed prior to the inspection include organizing the proper tools and equipment, reviewing the bridge structure files, and locating plans for the structure. The success of the on-site field inspection is largely dependent on the effort spent in preparing for the inspection. The major preparation activities include:

- Reviewing the bridge structure file
- Identifying the components and elements
- Developing an inspection sequence
- Preparing and organizing notes, forms, and sketches
- Arranging for traffic control
- Making arrangements for required methods of access
- Reviewing safety precautions
- Organizing tools and equipment
- Arranging for subcontract special activities
- Accounting for other special considerations

Review Bridge Structure File

The first step in preparing for a bridge inspection is to review the many available sources of information about the bridge, such as:

- "As-built" bridge plans
- Previous inspection reports
- Maintenance and repair records
- Rehabilitation/Retrofit plans
- Geotechnical data
- Hydrologic data
- Roadway plans
- Utility plans
- Right-of-way plans

Bridge Plans

The bridge plans contain information about the bridge type, the number of spans, the use of simple or continuous spans, and the materials of construction (see Figure 3.1.1). They also contain information about the presence of composite action between the deck and girders, the use of framing action at the substructure members, and the kind of connection details used. The year of construction and the design loading are also usually contained in the bridge plans.

Figure 3.1.1 Inspectors Reviewing Bridge Plans

Previous Inspection Reports

Previous inspection reports provide valuable information about the history of the bridge, documenting its condition in previous years. This information can be used to determine which components and elements of the bridge warrant special attention. It also allows the inspector to compare the current levels of deterioration with those noted during previous inspections to help determine the rate of deterioration.

Maintenance and Repair Records

Maintenance and repair records allow the inspector to report all subsequent repairs during the inspection phase, noting the types, extent, and dates of the repairs.

Rehabilitation Plans

Rehabilitation plans show modifications and replacements performed on the structure. Just as with the design plans, “As-Built (or record) drawings are preferable.

Geotechnical Data

Geotechnical data provides information about the foundation material below the structure. Sand, silt, or clay is more susceptible to settlement and scour problems than is rock. Therefore, structures founded on these materials should generally be given more attention with respect to foundation and scour issues than those founded on rock.

Hydrologic Data

Hydrologic data provides information about the shape and location of the channel, the presence of protection devices, flood frequencies, and water elevations for various flood intervals. This information is needed for scour evaluation, expected flood flows, and water velocity.

Roadway Plans

Roadway plans may not provide some information if the structure plans are not available.

Additional Data

Utility plans can be used to determine the types and numbers of utility attachments, and right-of-way plans can be used to determine the limits of the right-of-way, which can be a factor in determining access requirements.

Identify Components and Elements

Another important activity in preparing for the inspection is to establish the structure orientation, as well as a system for identifying the various components and elements of the bridge (see Figure 3.1.2). If drawings or previous inspection reports are available, the identification system used during the inspection should be the same as that used in these sources, with the exception of truss numbering as discussed below.

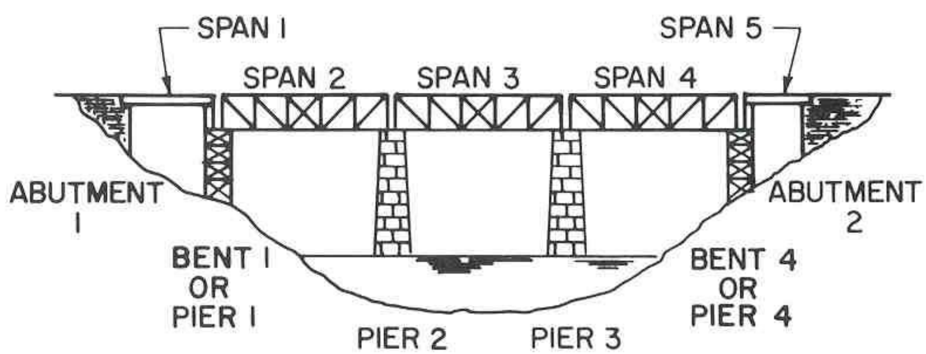


Figure 3.1.2 Sample Bridge Numbering Sequence

If no previous records are available, then the inspector should establish an identification system. The numbering system presented in this section is one possible system, but some states may use a different numbering system.

The route direction can be determined based on mile markers or stationing, and this direction should be used to identify the beginning and the end of the bridge.

Deck Element Numbering System

The deck element numbering system should include the deck sections (between construction joints), expansion joints, railing, parapets, and light standards. These elements should be numbered consecutively, from the beginning to the end of the bridge.

Superstructure Element Numbering System

The superstructure element numbering system should include the spans, the beams, and, in the case of a truss, the panel points. The spans should be numbered consecutively, with Span 1 located at the beginning of the bridge. Multiple beams should be numbered consecutively from left to right facing in the route direction. Similar to spans, floorbeams should be numbered consecutively from the beginning of the bridge, but the first floorbeam should be labeled as Floorbeam 0. This will coordinate the floorbeam and the bay numbers such that a given floorbeam number will be located at the end of its corresponding bay.

For trusses, the panel numbers should be numbered similarly to the floorbeams, beginning with Panel Point 0. Label both the upstream and downstream trusses. Points in the same vertical line have the same number. If there is no lower panel point in a particular vertical line, the numbers of the lower chord will skip a number (see Figure 3.1.3). Some design plans number to midspan on the truss and then number backwards to zero using prime numbers. However, this numbering system is not recommended for field inspection use since the prime designations in the field notes may be obscured by dirt.

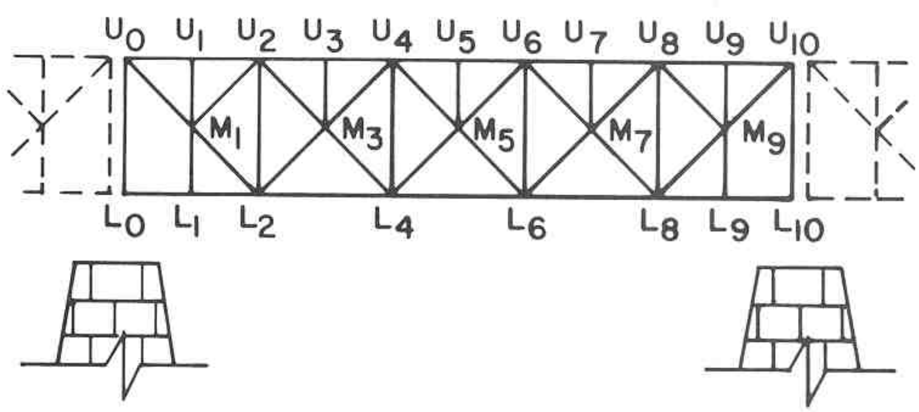


Figure 3.1.3 Sample Truss Numbering Scheme

Substructure Element Numbering System

The substructure element numbering system should include the abutments and the piers. Abutment 1 is located at the beginning of the bridge, and Abutment 2 is located at the end. The piers should be numbered consecutively, with Pier 1 located closest to the beginning of the bridge (see Figure 3.1.2). Alternatively, all the substructure units may be numbered consecutively without noting abutments or piers.

Develop Inspection Sequence

An inspection normally begins with the deck and superstructure elements and proceeds to the substructure. However, there are many factors that must be considered when planning a sequence of inspection for a bridge, including:

- Type of bridge
- Condition of the bridge components

- Overall condition
- Inspection agency requirements
- Size and complexity of the bridge
- Traffic conditions
- Special procedures

A sample inspection sequence for a bridge of average length and complexity is presented in Table 3.1.1. While developing an inspection sequence is important, it is of value only if following it ensures a complete and thorough inspection of the bridge.

1) Roadway Elements

- Approach roadways
- Traffic safety features
- General alignment
- Approach alignment
- Deflections
- Settlement

2) Deck Elements

- Bridge deck surface
- Expansion joints
- Sidewalks and railings
- Drainage
- Signing
- Electrical-lighting
- Barriers, gates, and other traffic control devices
- Bridge deck soffit

3) Superstructure Elements

- Bearings
- Main supporting members
- Secondary members and bracings
- Utilities
- Anchorages

4) Substructure Elements

- Abutments
- Skewbacks (arches)
- Slope protection
- Piers
- Footings
- Piles
- Curtain walls

5) Channel and Waterway Elements

- Channel profile and alignment
- Channel streambed
- Channel embankment
- Channel embankment protection
- Fenders
- Dolphins
- Hydraulic opening
- Water depth scales
- Navigational lights and aids

Table 3.1.1 Sample Inspection Item List

Prepare and Organize Notes

Preparing notes, forms, and sketches prior to the on-site inspection eliminates unnecessary work in the field. Copies of the agency's standard inspection form should be obtained for use in recordkeeping and as a checklist to ensure that the condition of all elements is noted.

Photocopy sketches from previous inspection reports so that defects previously documented can simply be updated. Preparing extra copies provides a contingency for sheets that may be lost or damaged in the field.

If previous sketches are not available, then pre-made, generic sketches may be used for repetitive features or members. Possible applications of this timesaving procedure include deck sections, floor systems, bracing members, abutments, piers, and retaining walls. Numbered, pre-made sketches and forms can also provide a quality control check on work completed.

Traffic Control

Bridge inspection, like construction and maintenance activities on bridges, often presents motorists with unexpected and unusual situations (see Figure 3.1.4). Most state agencies have adopted the federal *Manual on Uniform Traffic Control Devices for Streets and Highways* (*MUTCD*). Some state and local jurisdictions, however, issue their own manuals. When working in an area exposed to traffic, the bridge inspector should check and follow the governing standards. These standards will prescribe the minimum procedures for a number of typical applications and the proper use of standard traffic control devices, such as cones, signs, and flashing arrow boards.

Figure 3.1.4 Traffic Control Operation

Principles and procedures, which enhance the safety of motorists and bridge inspectors in work areas, include the following:

- Traffic safety should be a high priority element on every bridge inspection project where the inspectors' activities are exposed to traffic or likely to affect normal traffic movements.
- Traffic should be routed through work areas with geometrics and traffic control devices comparable to those employed for other highway situations.
- Traffic movement should be inhibited as little as practicable.
- Approaching motorists should be guided in a clear and positive manner throughout the bridge inspection site.
- On long duration inspections, routine inspection of traffic control devices should be performed.
- All persons responsible for the performance of traffic control operations should be adequately trained.

In addition, schedules may have to be adjusted to accommodate traffic control needs. For example, the number of lanes that can be closed at one time may require conducting the inspection operation with less than optimum efficiency. While it might be most efficient to inspect a floor system from left to right, traffic control may dictate working full length, a few beams at a time.

Special Considerations

Time Requirements

The inspection report or the bridge record file should state the amount of time required for the inspection. The inspection time requirements should be broken down into office preparation, travel time, field time, and report preparation. The overall condition of the bridge will play a major role in determining how long an inspection will take. Previous inspection reports provide an indication of the bridge's overall condition. It generally takes more time to inspect and document a deteriorated element (e.g., measuring, sketching, and photographing) than it does to simply observe and document that an element is in good condition.

Peak Travel Times

In populated areas, an inspection requiring traffic restrictions may be limited to certain hours of the day, such as 10:00 AM to 2:00 PM. Some days may be banned for inspection work altogether. Actual inspection time may be less than a 40-hour work week in these situations, and schedules should be adjusted accordingly.

Set-up Time

Set-up time must be considered both before and during the inspection. For example, rigging efforts may require several days before the inspectors arrive on the site. Also, other equipment, such as compressors and cleaning equipment, may require daily set-up time. Adequate time should be provided in the schedule for set-up and take-down time requirements. The time to install and remove traffic control devices must also be considered.

Access

Access requirements must also be considered when preparing for an inspection. Bridge members may be very similar to each other, but they may require different amounts of time to gain access to them. For example, it may take longer to maneuver a lift device to gain access to a floor system near utility lines than for one that is free of obstructions. On some structures, access hatches may need to be opened to gain access to a portion of the bridge.

Weather

Adverse weather conditions may not halt an inspection entirely, but may play a significant role in the inspection process. During adverse weather conditions, climbing should generally be avoided. There must be an increased awareness of safety hazards, and keeping notes dry can be difficult. During seasons of poor weather, a less aggressive schedule should be adopted than during the good weather months.

Safety Precautions

While completing the inspection in a timely and efficient manner, the importance of taking safety precautions cannot be overlooked. The inspection team must follow the general guidelines for safe inspections. Confined space entry procedures must be in accordance with OSHA and the owners' requirements. For climbing inspections, the three basic requirements for safe climbing must be followed. For additional information about safety precautions, refer to Topic 3.2.6.

Permits

When inspecting a bridge owned by or crossing a railroad, an access permit generally must be obtained before proceeding with the field inspection. A permit must also be obtained when inspecting bridges passing over navigable waterways.

Tools

To perform a complete and accurate inspection, the proper tools and equipment must be used. Bridge location and type are two main factors in determining required tools and equipment. Refer to Topic 3.4 for a complete list of inspection tools and equipment.

Subcontract Special Activities

Consideration must be given to time requirements when special activities must be scheduled. These activities may include one or more of the following:

- Maintenance and protection of traffic (M.P.T.)
- Access, including rigging, inspection vehicle(s), or a combination there of
- Coordination with various railroads, including obtaining the services of railroad flagmen

3.1.5 Performing the Inspection

This duty is the on-site work of accessing and examining bridge components and waterway, if present.

Inspection procedures as presented in the NBIS should always be followed.

Basic activities include:

- Visual examination of bridge components
- Physical examination of bridge components
- Evaluation of bridge components
- Examination and evaluation of the waterway beneath the structure, if any, and approach roadway geometry

General Inspection Procedures

Duties associated with the inspection include maintaining the proper structure orientation and member numbering system, developing an inspection sequence, and following proper inspection procedures.

The procedures used to inspect a bridge depend largely on the bridge type, the materials used, and the general condition of the bridge. Therefore, the inspector must be familiar with the basic inspection procedures for a wide variety of bridges. A first step in the inspection procedure is to establish the orientation of the site and of the bridge. The orientation should include the compass directions, the direction of waterway flow, and the direction of the inventory route. Also record inspection team, air temperature, weather conditions, and time.

After the site orientation has been established, the inspector is ready to begin the on-site inspection. The inspector must be careful and attentive to the work at hand, and no portion of the bridge should be overlooked. Those portions that are most critical to the structural integrity of the bridge should be given special attention. (Refer to Topic 8.1 for a description of fracture critical members in steel bridges.)

The prudence used during the inspection must be combined with thorough and complete recordkeeping. Observations should be careful and attentive, and every defect should be recorded. A very careful inspection is worth no more than the records kept during that inspection.

Numbers or letters should be crayoned or painted on the bridge to identify and code components and elements of the structure. The purpose of these marks is to keep track of the inspector's location and to guard against overlooking any portion of the structure.

The inspector should note the general approach roadway alignment, and sight along the railing and edge of the deck or girder to detect any misalignment or settlement.

Decks

The inspector should check the approach pavement for unevenness, settlement, or roughness. Also check the condition of the shoulders, slopes, drainage, and approach guardrail.

The deck and any sidewalks should be examined for various defects, noting size, type, extent, and location of each defect. The location should be referenced using the centerline or curb line, the span number, and the distance from a specific pier or joint.

Examine the expansion joints for sufficient clearance and for adequate seal. Record the width of the joint opening at both curb lines, noting the air temperature and the general weather conditions at the time of the inspection.

Finally, check that safety features, signs, and lighting are present, and note their condition.

Superstructures

The superstructure must be inspected thoroughly, since the failure of a main supporting member could result in the collapse of the bridge. The most common forms of main supporting members are:

- Beams and girders
- Floorbeams and stringers
- Trusses
- Catenary and suspender cables
- Eyebar chains
- Arch ribs
- Frames
- Pins and hanger plates

Bearings

The bearings must also be inspected thoroughly, since they provide the critical link between the superstructure and the substructure. Record the difference between the rocker tilt and a fixed reference line, noting the direction of tilt, the air temperature, and the general weather conditions at the time of the inspection.

Substructures

The substructure, which supports the superstructure, is made up of abutments, piers, and bents. If "as-built" plans are available, the dimensions of the substructure units should be compared with those presented on the plans. Since the primary method of bridge inspection is visual, all dirt, leaves, animal waste, and debris should be removed to allow close observation and evaluation. Substructure units should be checked for settlement by sighting along the superstructure and noting any tilting of vertical faces. In conjunction with the scour inspection of the waterway, the substructure units should be checked for undermining, noting both its extent and location.

Waterways

Waterways are dynamic in nature, with their volume of flow and their path continually changing. Therefore, bridges passing over them must be carefully inspected for the effects of these changes.

A record should be maintained of the channel profile and alignment, noting any meandering of the channel both upstream and downstream. Report any skew or improper location of the piers or abutments relative to the stream flow.

Scour, the erosion of a riverbed area caused by stream flow, is the primary concern when evaluating the effects of waterways on bridges (see Figure 3.1.5). The existence and extent of scour must be determined using a grid system and noting the depth of the channel bottom at each grid point.

Figure 3.1.5 Inspection for Scour and Undermining

Embankment erosion should be noted both upstream and downstream of the bridge, as should debris and excessive vegetation. Record their type, size, extent, and location. Note also the high water mark, referencing it to a fixed elevation such as the bottom of the superstructure.

Inspection of Bridge Elements

The inspector must be familiar with several general terms used to describe bridge defects:

- Corrosion – rusting
- Cracking - breaking away without separating into parts
- Splitting - separating into parts
- Connection slippage – relative movement of connected parts
- Overstress - deformation due to overload
- Collision damage - damage caused when a bridge is struck by vehicles or vessels

Refer to Section 2 for a more detailed list and description of types and causes of deterioration. As described in Section 2, each material is subject to unique defects. Therefore, the inspector should be familiar with the different inspection procedures used with each material.

Timber Inspection

When inspecting timber structures, determine the extent and severity of decay, weathering and wear, being specific about dimensions, depths, and locations. Sound and probe the timber to detect hidden deterioration due to decay, insects, or marine borers.

Note any large cracks, splits, or crushed areas. While collision or overload damage may cause these defects, the inspector should be factual, avoiding speculation as to the causes. Note any fire damage, recording the measurements of the remaining sound material. Document any exposed untreated portions of the wood, indicating the type, size, and location.

Concrete Inspection

When inspecting concrete structures, note all visible cracks, recording their type, width, length, and location. Any rust or efflorescence stains should also be recorded. Concrete scaling can occur on any exposed face of the concrete surface, and its area, location, depth, and general characteristics should be recorded. Inspect concrete surfaces for delamination or hollow zones, which are areas of incipient spalling, using a hammer or a chain drag. Delamination should be carefully documented using sketches showing the location and pertinent dimensions.

Unlike delamination, spalling is readily visible. Spalling should also be documented using sketches or photos, noting the depth of the spalling, the presence of exposed reinforcing steel, and any deterioration or section loss that may be present on the exposed bars.

Steel and Iron Inspection

When inspecting steel or iron structures, determine the extent and severity of corrosion, carefully measuring the amount of cross section remaining. All cracks should be noted, recording their length, size, and location. Bent or damaged members should be documented, noting the type of damage and amount of deflection.

Loose rivets or bolts can be detected by striking them with a hammer while holding a thumb on the opposite end of the rivet or bolt. Movement will be felt if it is loose. In addition, any missing rivets or bolts should also be noted.
Note any frozen pins, hangers, or expansion devices. One indication of this is if the hangers or expansion rockers are inclined or rotated in a direction opposite to that expected for the current temperature. In cold weather, a rocker bearing should lean towards the fixed end of the bridge, while in hot weather, it should lean away from the fixed end. A locked bearing is generally caused by heavy rust on the bearing elements.

For the inspector's evaluation to be substantiated, all inspection findings must be documented or recorded. Documentation is referred to as the "condition remarks" in the "inspection report".

3.1.6 Preparing the Report

Documentation is essential for any type of inspection. The inspector must gather enough information to ensure a comprehensive and complete report. Report preparation is a duty, which reflects the effort that the inspector puts into performing the inspection. Both must be comprehensive. The report is a record of both the bridge condition and the inspector's work.

Basic activities in preparing the inspection report include:

- Completion of agency forms
- Objective written documentation of all inspection findings
- Providing photo references and sketches
- Objective evaluation of bridge components
- Recommendations and cost estimates
- Summary

A sample bridge inspection report can be found in Appendix B of this manual.

3.1.7 Identifying Items for Repairs and Maintenance

The final basic duty is to identify items for repairs and maintenance. The inspector must identify such items to promote public safety and maximize longevity of the bridge.

Most recommendations concerning repairs will be in the category of programmed repairs (i.e., repairs that will be incorporated into preprogrammed repair and maintenance schedules). Examples of maintenance activities include: flushing the deck, flushing the scuppers and down spouting, lubricating the bearings and painting the structure.

The inspector must carefully consider the benefits to be derived from making repairs and the consequences if such repairs are not made. Also, the inspector should check the previous report recommendations to see what repairs and/or maintenance was identified and the priority of such items. If the repairs were to be completed before the next inspection, it is the responsibility of the inspector to note if the repairs have been completed and appear satisfactory.

3.1.8 Types of Bridge Inspection

The type of inspection may vary over the useful life of a bridge to reflect the intensity of inspection required at the time of inspection. The five types of inspections listed below will allow a Bridge Owner to establish appropriate inspection levels consistent with the inspection frequency and the type of structure and details.

Initial (Inventory)

An initial inspection is the first inspection of a bridge as it becomes a part of a bridge file, but the elements of an initial inspection may also apply when there has been a change in configuration of the structure (e.g., widening, lengthening, supplemental bents, etc.) or a change in bridge ownership. The initial inspection is a fully documented investigation and is accompanied by load capacity ratings. First, this inspection provides all Structure Inventory and Appraisal (SI&A) data. Second, it provides baseline structural conditions and identification of existing problems.

Routine (Periodic)

Routine inspections are regularly scheduled inspections consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from “initial” or previously recorded conditions, and to ensure that the structure continues to satisfy present service conditions. Inspection of underwater portions of the substructure is limited to observations during low-flow periods and/or probing for signs of undermining. The areas of the structure to be closely monitored are those determined by previous inspections and/or load rating calculations to be critical to load-carrying capacity.

Damage

A damage inspection is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions. The scope of inspection should be sufficient to determine the need for emergency load restrictions or closure of the bridge to traffic and to assess the level of effort necessary to effect a repair. A timely in-depth inspection may eliminate the need for this inspection.

In-Depth

An in-depth inspection is a close-up, hands-on inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures. When appropriate or necessary to fully ascertain the existence of or the extent of any deficiencies, nondestructive field tests may need to be performed. The inspection may include a load rating to assess the residual capacity of the member or members, depending on the extent of the deterioration or damage. For small bridges, the in-depth inspection should include all critical members of the structure. For large and complex structures, these inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, or details.

Special (Interim)

A special inspection is an inspection scheduled at the discretion of the Bridge Owner. It is used to monitor a particular known or suspected deficiency, such as foundation settlement or scour, fatigue damage, or the public’s use of a load posted bridge. Guidelines and procedures on what to observe and/or measure must be provided, and a timely process to interpret the field results should be in place. These inspections are not usually comprehensive enough to meet NBIS requirements for periodic inspections.

Table of Contents

Section 3
Fundamentals of
Bridge Inspection

Topic 3.2 Safety Practices

3.2.1 Key Concerns for Bridge Inspection Safety

While completing the inspection in a timely and efficient manner is important, safety is also a major concern in the field. Bridge inspection is inherently dangerous and therefore requires continual watchfulness on the part of each member of the inspection team. Attitude, alertness, and common sense are three important factors in maintaining safety. To reduce the possibility of accidents, we all need to be concerned about safety.

Five key motivations for bridge inspection safety:

- Injury and pain - Accidents can cause pain, suffering, and even death. Careless inspectors can severely injure or even kill themselves or others on the inspection team. Resulting pain and discomfort can hamper the inspector for the rest of their life.

- Family hardship - A worker's family also suffers hardship when an accident occurs. Not only is there loss of income, but there is also the inability to participate in family activities, or even, in the case of major disability, placing the burden of caring for the injured person on family members.

- Equipment damage - The repair or replacement of damaged equipment can be very costly. Not only is there the cost of fixing the damaged equipment, but there is also a cost due to the loss of time while the equipment is not available for use.

- Lost production - The employer not only loses revenues associated with the employee's work, but also loses time and money spent on safety training and equipment. Additional inspectors must be trained to replace the injured worker.

- Medical expenses - Whether coverage is an employee benefit, personal insurance, or out of pocket, someone has to pay for medical expenses. Ultimately, the tax-paying public pays the bill for accidents through higher insurance premiums.

Inspectors should constantly be aware of safety concerns. Spending the effort to be safe pays big dividends in avoided expenses and grief.

3.2.2 Safety Responsibilities

The employer is responsible for providing a safe working environment, including:

- Clear safety regulations and guidelines
- Safety training
- Proper tools and equipment

The supervisor is responsible for maintaining a safe working environment, including:

- Supervision of established job procedures
- Guidance in application of safety procedures
- Guidance in proper use of equipment
- Enforcement of safety regulations

Bridge inspectors are ultimately responsible for their own safety. The bridge inspector's responsibilities include:

- Recognition of physical limitations – Only you know what you are capable of doing. If you are uncomfortable doing something, let it be known.
- Knowledge of rules and requirements of job - If you do not understand something or do not feel qualified to perform a particular task safely, it is your responsibility to stop and ask questions. If a procedure appears to be unsafe, question it and constructively try to develop a better way.
- Safety of fellow workers - Do not endanger coworkers by your actions. Warn them if you see them doing something unsafe.
- Reporting an accident - If there is an accident, it is essential to report it to a designated individual in your agency or company within the prescribed time frame, usually within 24 hours. Any injury must be promptly reported in order to assure coverage, if necessary, under workmen's compensation or other insurance.

3.2.3 Personal Protection

Proper Inspection Attire

It is important to dress properly for the job. Field clothes should be properly sized for the individual, and they should be appropriate for the climate. For general inspection activities, the inspector should wear leather boots with traction lug soles. For climbing of bridge components, the inspector should wear boots with a steel shank (with non-slip soles without heavy lugs), as well as leather gloves. Wearing a tool pouch enables the inspector to carry tools and notes with hands free for climbing and other inspection activities.

Inspection Safety Equipment

Safety equipment is designed to prevent injury. However, the inspector must use the equipment in order for it to provide protection. The following are some common pieces of safety equipment:

Hard Hat

Wearing a hard hat can prevent serious head injuries in two ways. First, it provides protection against falling objects. The bridge site environment during inspection activities is prone to falling objects. Main concerns are:

- Deteriorated portions of bridge components dislodged during inspection
- Equipment dropped by coworkers overhead
- Debris discarded by passing motorists

Secondly, a hard hat protects the inspector's head from accidental impact with bridge components. When inspections involve climbing or access equipment, the inspector is frequently dodging various configurations of superstructure elements. These superstructure elements can be sharp edged and are always unyielding. If the inspector makes a mistake in judgement during a maneuver and impacts the structure, a hard hat may prevent serious injury.

During the inspection, the inspector never knows when protection will be needed. Therefore, a hard hat should be worn at all times. Also, if the inspector will be free climbing, it is a good practice to wear a chinstrap with the hard hat.

Figure 3.2.1 Inspector Wearing A Hard Hat

Reflective Safety Vest

When performing activities near traffic, the inspector is required to wear a safety vest. The vest should be bright orange with reflective strips. The combination of bright color and reflectivity makes the inspector more visible to passing motorists. When the motorist is aware of the inspector's presence, safety is improved.

Figure 3.2.2 Inspector Wearing A Reflective Safety Vest

Safety Goggles

Eye protection is necessary when the inspector is exposed to flying particles. Glasses with shatterproof lenses are not adequate if side protection is not provided. It is also important to note that only single lens glasses should be worn when climbing (no bifocals).

Eye protection should be worn during activities such as:

- Using a hammer
- Using a scraper or wire brush
- Grinding
- Shot or sand blasting
- Cutting
- Welding

During welding activities, protection with appropriate lenses specifically designed for welding should be used.

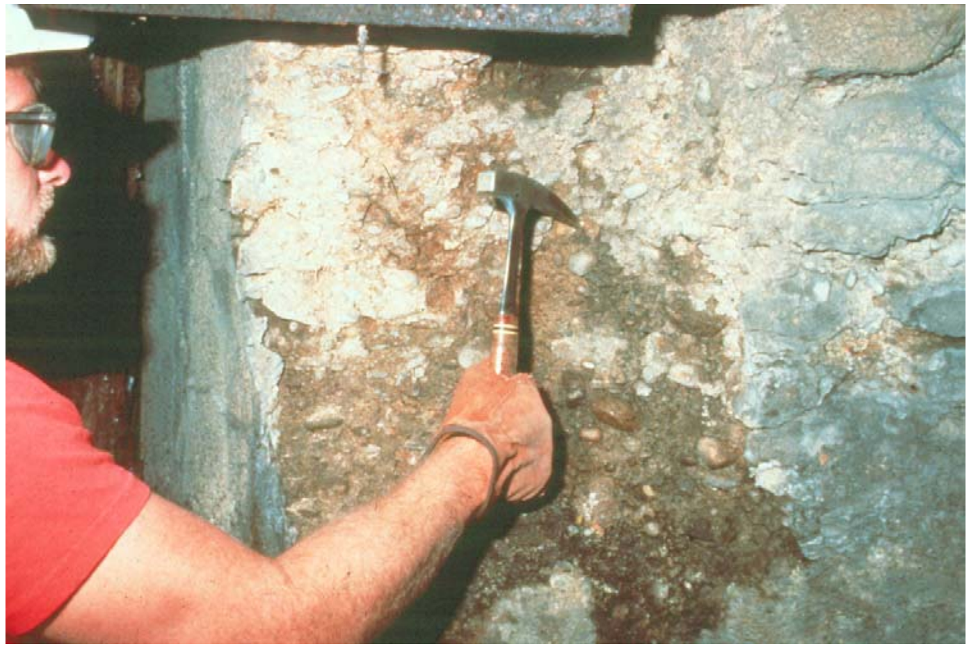


Figure 3.2.3 Inspector Wearing Safety Goggles

Life Jacket

A life jacket should always be worn when working over water or in a boat. If an accident occurs, good swimmers may drown if burdened with inspection equipment. Also, if knocked unconscious or injured due to a fall, a life jacket will keep the inspector afloat. A life jacket should also be worn when wearing hip or chest waders. If an inspector should slip or step in an area that is too deep, their waders can fill with water and drag them under, making swimming impossible.

Figure 3.2.4 Inspector Wearing a Life Jacket

Dust Mask / Respirator

A respirator or dust mask can protect the inspector from harmful airborne contaminants and pollutants. Agency or OSHA regulations should be consulted for approved types and appropriate usage.

Conditions requiring a respirator include:

- Sand blasting
- Painting
- Exposure to dust from pigeon droppings (exposure to pigeon droppings may result in histoplasonosis, a potentially very serious illness)
- Work in closed or constricted areas

Figure 3.2.5 Inspector Wearing a Respirator

Safety Harness and Lanyard

The safety harness and lanyard are the inspector's lifeline in the event of a fall. Use this equipment as required by conditions. Make sure you satisfy agency and OSHA requirements.

For example, one agency requires that a safety belt or harness be worn in the following situations:

- At heights over 6.0 m (20 feet)
- Above water
- Above traffic

Figure 3.2.6 Safety Harness with a Lanyard

To reduce the possibility of injury, the maximum lanyard length limits a fall to 1.8 m (6 feet) per OSHA regulations.

Further protection can be achieved using a shock absorber between the lanyard and the harness. The shock absorber reduces g-forces through the controlled extension of nylon webbing, which is pre-folded and sewn together.

The safety harness should be tied off to a solid structural member or to a safety line rigged for this purpose.

Do not tie off to scaffolding or its supporting cable. One of the reasons for tying off is to limit your fall in case the rigging or scaffold fails.

When working from a snooper or bucket truck, tie off to the structure if possible. Extreme caution must be exercised not to allow the equipment to be moved out from under someone tied to the bridge. If the machine is being moved frequently, it is best to tie off to the bucket or boom.

Gloves

Although one may not immediately think of gloves as a piece of safety equipment, they can prove to be an important safety feature. Wearing gloves will protect the inspector's hands from harmful effects of deteriorated members. In many inspections, structural members have been deteriorated to the point where the edges of the members have become razor sharp. These edges can cause severe cuts and lacerations to the inspector's hands that may become infected.

Boats

When performing an inspection over water, it is required to have a manned boat in the water at all times. In the event of an accident in which someone were to fall into the water, the boat can rescue them quickly. This is especially important if the individual has been rendered unconscious. In addition, it can also be used to retrieve any equipment that may have been accidentally dropped by an inspector.

3.2.4 Causes of Accidents

General

Accidents are usually caused by human error or equipment failure, but almost all accidents are due to human failings. People are not machines. We all make mistakes. Part of safety awareness is acknowledging this and planning ahead to minimize the effects of those mistakes.

Accidents caused by equipment failure can often be traced to inadequate or improper maintenance. Inspection, maintenance, and update of equipment can minimize failures.

Specific Causes

Specific causes of accidents include the following:

- Improper attitude - distraction, carelessness, worries over personal matters.
- Personal limitations - lack of knowledge or skill, exceeding physical capabilities.
- Physical impairment - previous injury, illness, side effect of medication, alcohol or drugs.
- Boredom - falling into an inattentive state while performing repetitive, routine tasks.
- Thoughtlessness - lack of safety awareness and not recognizing hazards.
- Shortcuts - sacrificing safety for time.
- Faulty equipment - damaged ladder rungs, worn rope, or frayed cables
- Inappropriate or loose fitting clothing.

3.2.5 Safety Precautions

General Precautions

Some general guidelines for safe inspections are as follows:

- Keeping well rested and alert - Working conditions encountered during an inspection are varied and can change rapidly requiring the inspector be fit and attentive.

- Maintaining proper mental and physical condition - Inspection tasks require a multitude of motor skills. To perform at acceptable levels, the inspector must be physically fit and free from mental distractions.

- Using proper tools - Do not try to use tools and equipment not suited for the job.

- Keeping work areas neat and uncluttered – Tools and equipment scattered carelessly about the work area present hazards that can result in injury.

- Establishing systematic procedures - Establish procedures early in the job utilizing them so everyone knows what to expect of one another.

- Follow safety rules and regulations - Adhere to the safety rules and regulations established by the Occupational Safety and Health Administration (OSHA), the agency, and your employer.

- Use common sense and good judgment - Do not engage in horseplay, and do not take short cuts or foolish chances.

- Avoid use of intoxicants or drugs - Intoxicants impair judgement, reflexes, and coordination.

- Medication - Prescription and over-the-counter medications can cause drowsiness or other unwanted and potentially dangerous side effects.

- Electricity - This is a potential killer. All cables and wires should be assumed to be hot (live), even if they appear to be telephone cables. The conditions encountered on many bridges are conducive to electric shock. These conditions include steel members, humidity, perspiration, and damp clothing. Transmission lines on a structure should be identified prior to the inspection. All power lines should be shut down. In rural areas, electric fences can be a hazard and should be avoided. Be aware that fiberglass posts eliminate the need for the distinctive porcelain insulation, which once identified electric fences.

- Assistance - Always work in pairs. An inspector should not take any action without someone else there to help in case of an accident. Always make sure someone else knows where you are. If someone seems to be missing, locate that person immediately.

- Inspection over water - A safety boat must be provided when working over bodies of water. It should be equipped with a life ring and have radio communication with the inspection crew.

- Waders - Caution should be used when wearing waders. If the inspector falls into a scour hole, the waders can fill with water, making swimming impossible.

- Inspection over traffic - It is best to avoid working above traffic. If it cannot be avoided, equipment, such as tools and notebooks, should be tied off.

- Entering dark areas - Use a flashlight to illuminate dark areas prior to entering as a precaution against falls, snakebites, and stinging insects.

Climbing Safety

There are three primary areas of preparation necessary for a safe climbing inspection:

1. Organization

2. Inspection Access Equipment

3. Mental attitude

Figure 3.2.7 Inspection Involving Extensive Climbing

Organization

Organization of the Inspection - A good inspection procedure incorporates a climbing strategy that minimizes climbing time. For example, beginning the day with an inspection of a truss span from one bent and finishing at the next bent by lunch time eliminates unproductive climbing across the span.

The inspection procedure should have an inspection plan so the inspector knows where to go, what to do, and what tools are needed to perform the inspection. An organized inspection reduces the chance of the inspector falling or getting stuck in a position in which he is unable to get down.

Weather conditions are a primary consideration when organizing a climbing inspection. Moderate temperatures and a sunny day are desirable.

Rain conditions warrant postponement of steel bridge inspections, as wet steel is extremely slippery.

After a rainy day, the inspector must be sure that boots are free of mud, and he must use extreme caution in areas where debris accumulation may cause a slippery surface.

Traffic should not be obstructed during bad weather.

Figure 3.2.8 Inclement Weather Causing Slippery Bridge Members

Inspection Equipment

The inspection team should be well equipped.

Personal attire should be checked for suitability to the job:

- Clothing - proper for climbing activities and temperature.
- Jewelry - rings, bracelets, and necklaces should never be worn; in an accident, jewelry can become snagged and cause additional injury.
- Eyeglasses - only single lens glasses should be worn; bifocals should not be worn because split vision impairs the inspector’s ability to climb safely.

Inspection equipment should be checked for proper use and condition.

Ladders

Accidents involving ladders are the most common type of inspection-related accident.

In order to use a ladder properly, these things are needed:

- Proper length for the job.
- 3:1 tilt with blocked and secured bottom.
- An assistant for ladders over 7.6 m (25 feet), and making sure the top is tied off.
- Inspecting the ladder, prior to use, for cracked or defective rungs and rails.
- Correct climbing technique using both hands, facing the ladder, and keeping your belt buckle over the rungs.
- Using a hand line to lift equipment or tools.

Figure 3.2.9 Proper Use of Ladder

Scaffolding

Scaffolding should be checked for the height and load capacity necessary to support the inspection team.

Load tests can be performed on the ground with planned equipment and personnel. A daily inspection for cracks, loose connections, and weak areas should be performed prior to use.

Timber Planks

Single planks should never be used. Two or more planks securely cleated together should be used. Plank ends should be securely attached to their supports. All planks should be inspected for knots, splits, cracks, and deterioration prior to use.

Inspection Vehicles

Use of platform trucks, bucket trucks, and underbridge inspection vehicles may be necessary to access all elements during an inspection. Confirm that they are in safe operating condition. Such equipment must only be used when placed on a firm surface at a slope not exceeding the rated capacity of the equipment.

Figure 3.2.10 Bucket Truck

Catwalks and Travelers

Permanent inspection access devices are ideal. However, the inspector should be on guard for deterioration of elements, such as flooring, hand-hold rods, and cables.

Figure 3.2.11 Inspection Catwalk

Rigging

The inspector should be familiar with proper rigging techniques. Support cables should be at least 13 mm (1/2 inch) in diameter. The working platform or "stage" should be at least 510 mm (20 inches) wide. A line or tie-off cable separate from the primary rigging should be used.

Use common sense with regard to rigging. Do not trust your life blindly to the riggers. If you feel a procedure is unsafe or doubtful, question it and get it changed if necessary. Do not rely on ropes or planks left on the bridge by prior work. They may be rotted or not properly attached.

Figure 3.2.12 Inspection Rigging

Mental Attitude

The inspector must be mentally prepared to do a climbing inspection. A good safety attitude is of foremost importance. Three precautions that must be addressed are:

- Avoid emotional distress - Do not climb when emotionally upset. The inspector who climbs must have complete control; otherwise the chances of falling increase.

- Know where you are - Always be aware of where you are and what you are doing when climbing. Do not become so engrossed in the job that you step into mid-air.

- Do not do anything you are not confident of doing safely. If there is a feature you cannot safely inspect with the equipment available, do not do it. Highlight this fact in the notes so that appropriate equipment can be scheduled if necessary. Do not hide the fact that something was not inspected.

Confined Spaces

Safety Concerns

Inspection of box girder bridges, steel box pier caps, steel arch rings, arch ties, cellular concrete structures, and long culverts often includes confined spaces. Confined space entry is regulated by OSHA and requires proper training, equipment, and permitting.

There are four major concerns when inspecting a confined space:

- Lack of oxygen - oxygen content must remain above 19% for the inspector to remain conscious
- Toxic gases - generally produced by work processes such as painting, burning, and welding or by operation of internal combustion engines
- Explosive gases - natural gas, methane, or gasoline vapors may be present naturally or due to leaks
- Lack of light – many confined spaces are totally dark (inspector cannot see any potential hazards such as depressions, drop-offs, or dangerous animals)

Safety Procedures

When a confined area must be inspected, the safety procedures prescribed by OSHA and any additional agency requirements must be followed.

The following is a general description of the basic requirements. Refer to OSHA for specifics.

Pre-entry air tests:

- Test for oxygen with an approved oxygen testing device
- Test for other gases, such as carbon monoxide, hydrogen sulfide, methane, natural gas, and combustible vapors

Mechanical ventilation:

- Pre-entry - Oxygen and gas levels must be acceptable for a minimum prescribed time prior to entry.
- During occupancy - Ventilation should be continuous regardless of activities. Test for oxygen and other gases at prescribed intervals during occupancy.

Basic safety procedures:

- Avoid use of flammable liquids in the confined area.
- Position inspection vehicles away from the area entrance to avoid carbon monoxide fumes.
- Position gasoline powered generators "down-wind" of operations.
- Operations producing toxic gases should be performed "down-wind" of the operator and the inspection team.
- Carry approved rescue air-breathing apparatus.
- Use adequate lighting with an appropriate backup system and lifelines when entering dark areas, such as box girders and culverts.
- Inspection should be performed in pairs, with a third inspector remaining outside of dark or confined areas.

Culverts

There are several hazards that can be encountered when performing a culvert inspection. Being aware of these situations and exercising proper precautions will protect the inspector from these dangerous and potentially life threatening hazards. The following are some of the hazardous conditions an inspector may encounter.

- Inadequate Ventilation
- Drowning
- Toxic Chemicals
- Animals
- Quick Conditions
- Insufficient Number of Inspectors

Inadequate Ventilation

Culverts with inadequate ventilation can develop low oxygen levels or high concentrations of toxic and/or explosive gases. This is a big concern when one culvert end may be blocked or inspection is being performed on a long culvert.

If air quality is suspect, tests should be made to determine the concentration of gases. Testing devices may be as simple as badges worn by inspectors that change colors when in the presence of a particular gas. Devices may also be sophisticated instruments that measure the concentration of several gases.

Confined space entry requirements should be observed when inspecting a long culvert or any culvert with restricted ventilation.

Drowning

Extensive streambed erosion may result in scour holes. During periods of low flow the depth of water in these holes may be significantly greater than the remainder of the streambed. This could give the inspector the impression that wading is safe. It is advisable that the inspector use a probing rod to check water depth wherever he/she plans to walk.

Storms may generate high flows in culverts very quickly. This creates a dangerous situation for the inspectors. It is not uncommon for culverts to carry peak flow long before a storm reaches the culvert site. Inspectors should be cautious whenever storms appear imminent.

Toxic Chemicals

Occasionally, stream flow may contain hazardous chemicals from any of a number of sources. Fires, explosions, and serious illness could result from the presence of such chemicals if appropriate precautions are not taken.

Animals

An accumulation of dirt or debris may provide a home for snakes, rodents, or other animals. These could provide a problem to the inspector. An inspector's ability to react to these hazards may be compromised by poor lighting and inadequate room to move. Also, dead animals may be present.

Quick Conditions

Quicksand conditions can occur in sandy streambeds, especially at the outlet end of the culvert. Inspectors should be aware of this and should proceed with caution in geographical areas known to have these problems.

This page intentionally left blank

Table of Contents

Section 3
Fundamentals of
Bridge Inspection

This page intentionally left blank

Topic 3.3 Traffic Control

3.3.1 Introduction

This topic describes the traffic control procedures required for a relatively short term closure (only a day or two). Long term or more permanent construction closures using concrete barriers are not included in this topic.

Figure 3.3.1 Traffic Control Operation

Bridge inspection, like construction and maintenance activities on bridges, often presents motorists with unexpected and unusual situations. Most state agencies have adopted the federal *Manual on Uniform Traffic Control Devices for Streets and Highways* (*MUTCD*). Some states and local jurisdictions, however, issue their own manuals.

When working in an area exposed to traffic, the bridge inspector should check and follow the existing standards. These standards will prescribe the minimum procedures for a number of typical applications and the proper use of standard traffic control devices such as cones, signs, and flashing arrow-boards.

3.3.2 Philosophy and Fundamental Principles

All traffic control devices used on street and highway construction or maintenance work should conform to the applicable specifications of the *MUTCD* and the agency.

Principles and procedures which have been shown to enhance the safety of motorists, pedestrians, and workers in the vicinity of work areas include the following:

Inform the Motorists

Traffic safety in work zones should be an integral and high priority element of every inspection project, from the planning stage to performance of the inspection.

The safety of the motorist, pedestrian, and worker must be kept in mind at all times.

The basic safety principles governing the design of permanent traffic control for roadways and roadsides should also govern the design of inspection sites. The goal should be to route traffic through such areas with geometrics and traffic control devices comparable to those for normal highway situations.

The situation and expected actions must be clearly communicated to the driver.

A traffic control plan, in detail appropriate to the complexity of the work project, should be prepared and understood by all responsible parties before the site is occupied. Any changes in the traffic control plan should be approved by an official trained in safe traffic control practices.

Control The Motorists

Traffic movement should be inhibited as little as practical.

Traffic control in work sites should be designed on the assumption that motorists will only reduce their speeds if they clearly perceive a need to do so. Reduced speed zoning should be avoided as much as practical.

The objective is a traffic control plan that uses a variety of traffic control measures and devices in whatever combination necessary to assure smooth, safe vehicular movement past the work area and at the same time provide safety for the equipment and the workers on the job.

Frequent and abrupt changes in geometrics, such as lane narrowing, dropped lanes, or main roadway transitions that require rapid maneuvers, should be avoided.

Provisions should be made for the safe operation of work vehicles, particularly on high speed, high volume roadways. This includes the use of roof mounted flashing lights or flashers when entering or leaving the work zone. This also includes considering the number of lanes that can be closed at one time for an operation. While it might be most cost efficient to inspect a floor system from left to right, traffic control may dictate working full length, a few beams at a time.

Inspection time should be minimized to reduce exposure to potential hazards without compromising the thoroughness of the inspection.

Provide a Clearly Marked Path

Motorists should be guided in a clear and positive manner while approaching and traversing work areas.

Adequate warning, delineation, and channelization should be provided to assure the motorist positive guidance in advance of and through the work area. Proper signing and other devices which are effective under varying conditions of light and weather must be used.

All traffic control devices should be removed immediately when no longer needed.

The maintenance of roadside safety requires constant attention during the life of the work because of the potential increase in hazards.

To accommodate run-off-the-road incidents, disabled vehicles or other emergency situations, it is desirable to provide an unencumbered roadside recovery area that is as wide as practical.

Channelization of traffic should be accomplished by the use of signing, flexible posts, barricades, and other lightweight devices which will yield when hit by errant vehicles.

Whenever practical, equipment and materials should be stored in such a manner as not to be vulnerable to run-off-the-road vehicle impact. When safe storage is not available, adequate attenuation devices should be provided.

The goal of a good traffic control plan is the safe and efficient movement of motorists and pedestrians and the protection of bridge inspectors at work areas.

3.3.3 Inspector Safety Practices

Work Zone

Traffic represents as great, or even greater, threat to the inspector's safety than climbing high bridges. The work zone is intended to be a safe haven from traffic so the inspectors can concentrate on doing their jobs.

As such, the work zone needs to be clearly marked so as to guide the motorist around it and, insofar as possible, prevent errant vehicles from entering. The work zone should be as compact as possible to minimize traffic disruption, but must be wide enough and long enough to permit access to the area to be inspected and allow for safe movement of workers and equipment. The end of the work zone should be clearly signed as a courtesy to the motorist.

Figure 3.3.2 Work Zone

Vehicles and Equipment

Inspection vehicles and equipment need to be made visible to the motorists with flashing marker lights or arrow boards as appropriate.

Vehicles entering and exiting the work zone should use a roof mounted flashing light or flashers to distinguish themselves from other motorists. Also, all vehicles should use extreme caution when moving in and out of the work zone. Allow traffic ample time to react to the vehicle's movements.

Figure 3.3.3 Inspection Vehicles with Flashing Light

Workers

Individuals in a work zone must wear approved safety vests and hard hats for visibility and identification. They also help make the inspector look “official” to the public. The inspectors should also stay within the work zone for their own safety.

Figure 3.3.4 Inspector with a Safety Vest and Hard Hat

3.3.4 Requirements of Traffic Control Devices

Each job is different and has traffic concerns that are unique to that location. Selection of the proper traffic control device's for each location is dependent upon many factors. Though there are several different types of traffic control devises, there are some basic requirements for efficient traffic control devices:

1. They must be visible and attention getting.

   - Bright colors make devices easier to see.

   - All signs must be legible and color distinguishable at night as well as during the day. Nighttime sign visibility is provided through retroreflectivity, which is accomplished by spherical glass beads or prismatic reflectors in the sign material. The headlights reflect off the sign and back to the driver, making the sign visible at night.

   - New sign messages such as “Slow Down. My Daddy Works Here” and “Give Us A Brake. Slow Down” cause the driver to think on a more personal level.

2. They must give clear direction.

3. They must command respect. They should be official (*MUTCD*).

4. They must elicit the proper response at the proper time.

   - The decision process includes the classical chain of sensing, perceiving, analyzing, deciding, and responding.

- The average perception-reaction time of a driver is 2.5 seconds. At 60 mph, that 2.5 seconds translates to 220 feet (67 m).

- Traffic control must accommodate a wide range of vehicles (from small compact cars to large combination tractor-trailers) and driver skills, which may be impaired by alcohol, drugs, or drowsiness.

All of these requirements for traffic control devices have been factored into the various agencies' guidelines for work area traffic control. These guidelines represent efforts by trained people. Do not make up your own traffic patterns.

3.3.5 Types of Traffic Control Devices

Signs

Examples of traffic control signs include the following:

- Regulatory - "Speed Limit 40 mph", "DO NOT PASS", may require special authority
- Warning - "Bridge Inspection", "Work Area Ahead", "Slow"
- Guide Signs - Directional and destination signs; not used for bridge inspection traffic control unless a detour is established
- Changeable Message Signs – Can display more than one message

Figure 3.3.5 Work Area Speed Limit Sign (Regulatory)

Figure 3.3.6 Traffic Control Sign (Warning)

Channelizing Devices

The functions of channelizing devices are to warn and alert drivers of hazards created by construction or maintenance activities in or near the traveled way and to guide and direct drivers safely past the hazards.

Devices used for channelization should provide a smooth and gradual transition in moving traffic from one lane to another, onto a bypass or detour, or in reducing the width of the traveled way. If possible, they should be constructed so as not to inflict any undue damage to a vehicle that inadvertently strikes them.

Channelizing devices are elements in a total system of traffic control devices for use in highway construction and maintenance operations. These elements should be preceded by a subsystem of warning devices that are adequate in size, number, and placement for the type of highway on which the work is to take place.

Typical channelizing devices include the following:

- Cones
- Drums
- Wands
- Vertical panels
- Portable concrete barrier sections (these are seldom applicable to bridge inspection due to the short duration of the work)

Figure 3.3.7 Traffic Control Cones

Figure 3.3.8 Vertical Panels – Note panels attached to drums

Lighting

Another type of control device is lighting. Examples of lighting include the following:

- Flashers - attached to signs or other devices to attract attention or for night visibility

- Arrowboards - for lane control

- Floodlights - to illuminate the work area at night and/or to assist motorists in negotiating a restricted area; should only be required for bridge inspection in emergencies or in extremely high traffic volume areas where lane restrictions are only feasible at night; aim floodlights so driver's vision is not impaired.

Figure 3.3.10 Arrowboard

Flaggers

A number of hand signalizing devices, such as STOP/SLOW paddles, lights, and red flags, are used to control traffic through work zones. The sign paddle bearing the clear messages "STOP" or "SLOW" provides motorists with more positive guidance than flags and is generally the primary hand signaling device. Flag use should be limited to emergency situations and at spot locations that can best be controlled by a single flagger, if permitted by the agency.

Since flaggers are responsible for human safety and make the greatest number of public contacts of all construction personnel, it is important that qualified personnel be selected. A flagger should possess the following minimum qualifications:

- Good common sense
- Good physical condition, including sight and hearing
- Mental alertness
- Courteous but firm manner
- Neat appearance
- Sense of responsibility for safety of public and crew
- Training in safe traffic control practices

The use of hard hat and orange clothing, such as a vest, shirt, or jacket, should be required for flaggers. For nighttime conditions, similar outside garments should be reflectorized.

Flaggers are provided at work sites to stop traffic intermittently as necessitated by work progress. They also maintain continuous traffic past a work site at reduced speeds to help protect the work crew. For both of these functions, the flagger must, at all times, be clearly visible to approaching traffic for a distance sufficient to permit proper response by the motorist to the flagging instructions and to permit traffic to reduce speed before entering the work site (generally several hundred feet, depending on site conditions). In positioning flaggers, consideration must be given to maintaining color contrast between the work area background and the flagger's protective garments.

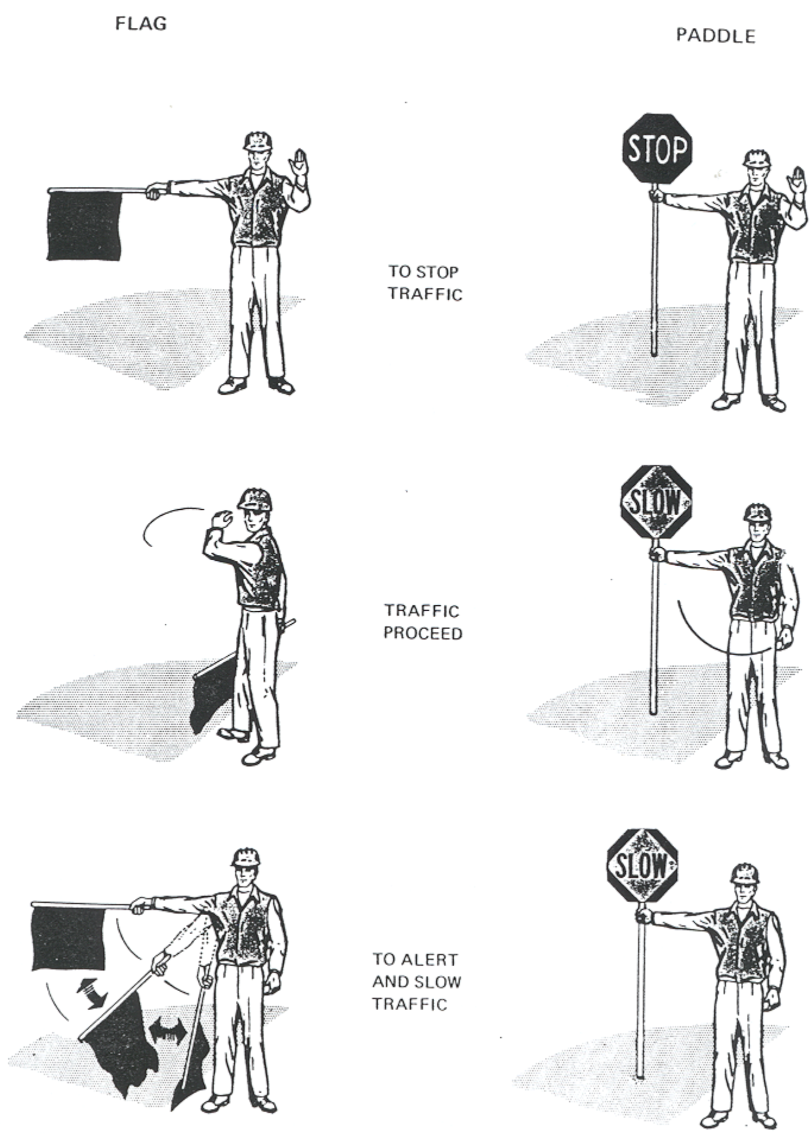


Figure 3.3.11 Use of Hand Signaling Devices by Flagger (from *MUTCD*)

The following methods of signaling with sign paddles should be used:

- To stop traffic - The flagger should face traffic and extend the STOP sign paddle in a stationary position with the arm extended horizontally away from the body. The free arm is raised with the palm toward approaching traffic.

- When it is safe for traffic to proceed - The flagger should face traffic with the SLOW sign paddle held in a stationary position with the arm extended horizontally away from the body. The flagger motions traffic ahead with the free hand.

- When it is desired to alert or slow traffic - The flagger shall face traffic with the SLOW sign paddle held in a stationary position with the arm extended horizontally away from the body.

The following methods of signaling with a flag should be used:

- To stop traffic - The flagger should face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis, the free arm may be raised with the palm toward approaching traffic.

- When it is safe for traffic to proceed - The flagger should stand parallel to the traffic movement and, with flag and arm lowered from view of the driver, motion traffic ahead with the free arm. Flags should not be used to signal traffic to proceed.

- Where it is desired to alert or slow traffic - The flagger should face traffic and slowly wave the flag in a sweeping motion of the extended arm from the shoulder level to straight down without raising the arm above a horizontal position.

Lights approved by the appropriate highway authority or reflectorized sign paddles or reflectorized flags should be used to flag traffic at night.

Whenever practicable, the flagger should advise the motorist of the reason for the delay and the approximate period that traffic will be halted. Flaggers and operators of machinery or trucks should be made to understand that every reasonable effort must be made to allow the driving public the right-of-way and prevent excessive delays.

Flagger stations should be located far enough in advance of the work site so that approaching traffic will have sufficient distance to reduce speed before entering the project. This distance is related to the approach speed and physical conditions at the site; however, 200 to 300 feet (60 to 90 m) is desirable. In urban areas, where speeds are low and streets are closely spaced, the distance necessarily must be decreased.

The flaggers should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. At a spot obstruction, a position may have to be taken on the shoulder opposite the barricaded section to operate effectively.

Under no circumstances should a flagger stand in the lane being used by moving traffic. The flagger must be clearly visible to approaching traffic at all times. For this reason, the flagger must stand alone, never permitting a group of workers to congregate around the flagger station. The flagger should be stationed sufficiently in advance of the work force to warn them of approaching danger, such as out-of-control vehicles.

Figure 3.3.12 Flagger with Stop/Slow Paddle

Flagger stations should be adequately protected and preceded by proper advance warning signs. At night, flagger stations should be adequately illuminated.

At short lane closures where adequate sight distance is available for the safe handling of traffic, the use of one flagger may be sufficient.

One-way Traffic Control

Where traffic in both directions must, for a limited distance, use a single lane, provisions should be made for alternate one-way movement to pass traffic through the constricted section. At a spot obstruction, such as a short bridge, the movement may be self-regulating. However, where the one-lane section is of any length, there should be some means of coordinating movements at each end so that vehicles are not simultaneously moving in opposite directions in the section and so that delays are not excessive at either end. Control points at each end of the route should be chosen so as to permit easy passing of opposing lines of vehicles.

Alternate one-way traffic control may be facilitated by the following means:

- Flagger control
- Flag-carrying or official car
- Pilot car
- Traffic signals

Flagger control is usually used for bridge inspection, where the one-lane section is short enough so that each end is visible from the other end. Traffic may be controlled by means of a flagger at each end of the section. One of the two should be designated as the chief flagger to coordinate movement. They should be able to communicate with each other verbally or by means of signals. These signals should not be such as to be mistaken for flagging signals.

Where the end of a one-way section is not visible from the other end, the flaggers may maintain contact by means of radio or field telephones. So that a flagger may know when to allow traffic to proceed into the section, the last vehicle from the opposite direction can be identified by description or license.

Shadow Vehicles

Shadow Vehicles with truck Mounted attenuators (TMAs) are used to prevent vehicles from entering the work zone if the operator ignores the lane closure signs and channelization. Each agency has its own specific requirements, but a shadow vehicle should generally be employed any time a shoulder or travel lane will be occupied by workers or equipment.

- The requirements for the truck itself vary, but high visibility with flashing lights, a striped panel, or an arrow board on the rear of a vehicle of a specified minimum weight are generally required.
- Some jurisdictions use truck or trailer mounted attenuators. This protects the motorist, as well as the inspectors.

Figure 3.3.13 Shadow Vehicle with Attenuator

Police Assistance

On some inspection jobs, police assistance may be helpful and even required. The presence of a patrol car aids in slowing and controlling the public. At a signalized intersection near a job site, a police officer may be required to ensure traffic flows properly and smoothly.

3.3.6 Public Safety

Since the fundamental goal of bridge inspection is to enhance public safety, it would make little sense to endanger that same public by inadequate traffic control measures. Traffic control does take time, money, and effort. It is, however, a necessary part of the business of bridge inspection.

In the broadest sense, the motorist is the customer of everyone in the transportation industry. Like everyone else, bridge inspectors need to treat customers well, inconveniencing them as little as possible and protecting their safety. This means providing well thought out, clear, and effective traffic control measures.

Pedestrians also must be considered. If a walkway must be closed, it should be properly signed and barricaded. An alternate route for the walker should be indicated, if necessary through or preferably around the work zone.

Training

Each person whose actions affect maintenance and construction zone safety (from the upper-level management personnel to construction and maintenance field personnel) should receive training appropriate to the job decisions each individual is required to make. Only those individuals who are qualified by means of adequate training in safe traffic control practices and have a basic understanding of the principles established by applicable guidelines and regulations should supervise the selection, placement, and maintenance of traffic control devices in bridge safety inspection, maintenance, and construction areas.

Responsibility

Legally and morally, it is the inspector's responsibility to follow the regulations and guidelines of the agency having jurisdiction.

The primary goal of good traffic control is safety – safety of the workers and safety of the motorists. A secondary goal is to be able to defend yourself and your employer should there be an accident. Accidents bring lawsuits. Lawsuits bring inquiries about who did what. One thing investigated during a lawsuit will be whether or not the standards and regulations were followed. Anything not done in accordance with published standards, regulations, and directives could bring blame upon whoever violated the regulation. Being blamed for an accident is expensive and damaging.

This page intentionally left blank

Table of Contents

Section 3
Fundamentals of
Bridge Inspection

This page intentionally left blank

Topic 3.4 Inspection Equipment

3.4.1 Equipment Necessity

Several factors play a role in what type of equipment is needed for an inspection. Bridge location and type are two of the main factors in determining equipment needs. If the bridge is located over water, certain pieces of equipment such as life jackets and boats are important to have. Also, if the bridge is made of timber, then specific pieces of equipment like increment borers and ice picks are needed, whereas they would not be necessary on a steel or concrete bridge. Another factor influencing equipment needs is the type of inspection. It is therefore important to review every facet about the bridge before heading out on an inspection. A few minutes spent reviewing the bridge files and making a list of the necessary equipment can save hours of wasted inspection time in the field if the inspectors do not have the required equipment.

3.4.2 Standard Tools

In order for the inspector to perform an accurate and comprehensive inspection, the proper tools must be used. Standard tools that an inspector should have available at the bridge site can be grouped into seven basic categories:

- Tools for cleaning (see Figure 3.4.1)
- Tools for inspection (see Figure 3.4.2)
- Tools for visual aid (see Figure 3.4.3)
- Tools for measuring (see Figure 3.4.4)
- Tools for documentation
- Tools for access
- Miscellaneous equipment

Figure 3.4.1 Tools for Cleaning

Figure 3.4.2 Tools for Inspection

Figure 3.4.3 Tools for Visual Aid

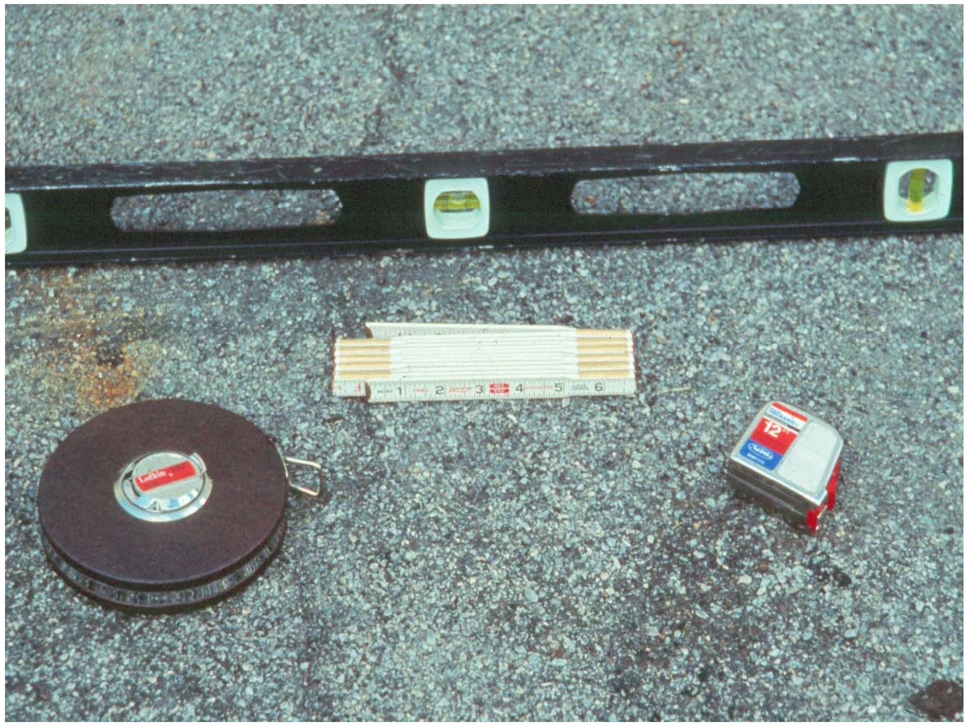


Figure 3.4.4 Tools for Measuring

Tools for Cleaning

Tools for cleaning include:

- Wisk broom - used for removing loose dirt and debris
- Wire brush - used for removing loose paint and corrosion from steel elements
- Scrapers (2 inch or 50 mm) - used for removing corrosion or growth from element surfaces
- Flat bladed screwdriver - used for general cleaning and probing
- Shovel - used for removing dirt and debris from bearing areas

Tools for Inspection

Tools for inspection include:

- Pocket knife - used for general duty
- Ice pick - used for surface examination of timber elements
- Hand brace and bits - used for boring suspect areas of timber elements
- Increment borer - used for internal examination of timber elements
- Chipping hammer with leather holder (16 ounce geologist's pick) - used for loosening dirt and rust scale, sounding concrete, and checking for sheared or loose fasteners
- Plumb bob - used to measure vertical alignment of a superstructure or substructure element
- Tool belt with tool pouch - used for convenient holding and access of small tools
- Chain drag - used to identify areas of delamination on concrete decks
- Range pole / probe - used for probing for scour holes

Tools for Visual Aid

Tools for visual aid include:

- Binoculars - used to preview areas prior to inspection activity and for examination at distances

- Flashlight - used for illuminating dark areas
- Lighted magnifying glass (e.g., five power and 10 power) - used for close examination of cracks and areas prone to cracking
- Inspection mirrors - used for inspection of inaccessible areas (e.g., underside of deck joints)
- Dye penetrant - used for identifying cracks and their lengths

Tools for Measuring

Tools for measuring include:

- Pocket tape (6 foot rule) - used to measure defects and element and joint dimensions
- 25 foot and 100 foot tape - used for measuring component dimensions
- Calipers - used for measuring the thickness of an element beyond an exposed edge
- Optical crack gauge - used for precise measurements of crack widths
- Paint film gauge - used for checking paint thickness
- Tiltmeter and protractor - used for determining tilting substructures and for measuring the angle of bearing tilt
- Thermometer - used for measuring ambient air temperature and superstructure temperature
- 4 foot carpenter's level - used for measuring deck cross-slopes and approach pavement settlement
- D-Meter (ultrasonic thickness gauge) - used for accurate measurements of steel thickness
- Electronic Distance Meter (EDM) - used for accurate measurements of span lengths and clearances when access is a problem
- Line level and string line

Tools for Documentation

Tools for documentation include:

- Inspection forms, clipboard, and pencil - used for record keeping for most bridges
- Field books - used for additional record keeping for complex structures
- Straight edge - used for drawing concise sketches
- 35 mm camera - used for visual documentation of the bridge site and conditions
- Polaroid camera - used to provide instant documentation for serious conditions which require immediate review by office personnel
- Digital camera - used to provide digital images of defects which can be downloaded and e-mailed for instant assessment
- Chalk, keel, paint sticks, or markers - used for element and defect identification for improved organization and photo documentation
- Center punch - used for applying reference marks to steel elements for movement documentation (e.g., bearing tilt and joint openings)
- "P-K" nails - Parker Kalon masonry survey nails used for establishing a reference point necessary for movement documentation of substructures and large cracks

Tools for Access

Some common tools for access include:

- Ladders - used for substructures and various areas of the superstructure
- Boat - used for soundings and inspection; safety for over water work
- Rope - used to aid in climbing
- Waders - used for shallow streams

Tools for access are described in further detail in Topic 3.5.2.

Miscellaneous Equipment

Miscellaneous equipment should include:

- "C"-clamps - used to provide a "third hand" when taking difficult measurements
- Penetrating oil - aids removal of fasteners, lock nuts, and pin caps when necessary
- Insect repellent - reduces attack by mosquitoes, ticks, and chiggers
- Wasp and hornet killer - used to eliminate nests to permit inspection
- First-aid kit - used for small cuts, snake bites, and bee stings
- Dust masks or respirators - used to protect against inhalation in dusty condition or work around pigeon droppings
- Coveralls - used to protect clothing and skin against sharp edges while inspecting
- Life jacket - used for safety over water
- Cell phone - used to call in emergencies
- Toilet paper - used for other "emergencies" (better safe than sorry)

3.4.3 Special Equipment

For the routine inspection of a common bridge, special equipment is usually not necessary. However, with some structures, special inspection activities require special tools. These special activities are often subcontracted by the agency responsible for the bridge. The inspector should be familiar with special equipment and its application.

Survey Equipment

Special circumstances may require the use of a transit, a level, an incremental rod, or other survey equipment. This equipment can be used to establish a component's exact location relative to other components, as well as an established reference point.

Nondestructive Testing Equipment

Nondestructive testing (NDT) is the in-place examination of a material for structural integrity without damaging the material. NDT equipment allows the inspector to "see" inside a bridge element and assess deficiencies that may not be visible with the naked eye. Generally, a trained technician is necessary to conduct NDT and interpret their results. For a more detailed description of NDT, refer to Topics 13.1.2, 13.2.2, and 13.3.2.

Underwater Inspection Equipment

Underwater inspection is the examination of substructure units and the channel below the water line. When the waterway is shallow, underwater inspection can be performed above water with a simple probe. Probing can be performed using a piece of reinforcing steel, a survey rod, a folding rule, or even a tree limb.

When the waterway is deep, underwater inspection must be performed by trained divers. This requires special diving equipment that includes a working platform, fathometer, ground penetrating radar, air supply systems, radio communication, and sounding equipment. Refer to Topic 11.3 for a more detailed description of underwater inspection equipment.

Other Special Equipment

An inspection may require special equipment to prepare the bridge prior to the inspection. Such special equipment includes:

- Air-water jet equipment - used to clean surfaces of dirt and debris
- Sand or shot blasting equipment - used to clean steel surfaces to bare metal
- Burning, drilling, and grinding equipment

3.4.4 Primary Safety Concerns

The main safety concerns in any inspection are the public and the inspectors. Having the proper equipment can play a key role in maintaining the safety of both. When inspectors do not have the right equipment, they may attempt to use an alternate piece of equipment that is not really designed for the job. This cannot only prove dangerous for the inspector, but for the public as well. Inspectors should never try to replace equipment in the interest of saving time. The best way to avoid these circumstances is to ensure the inspectors have the proper equipment for the job. This responsibility lies not only with the inspector but also their employer. It is important that the employer make every effort to properly equip all the inspectors. Also, the inspector should be familiar with every piece of equipment and how to use and operate it properly.

Table of Contents

Section 3
Fundamentals of
Bridge Inspection

This page intentionally left blank

Topic 3.5 Methods of Access

3.5.1 Introduction

The two primary methods of gaining access to hard to reach areas of a bridge are access equipment and access vehicles. Common access equipment includes ladders, rigging, and scaffolds, while common access vehicles include manlifts, bucket trucks, and snoopers. In most cases, using a manlift or bucket truck will be less time consuming than using a ladder or rigging to inspect a structure. The time saved, however, must offset the high costs associated with operating access vehicles.

3.5.2 Types of Access Equipment

The purpose of access equipment is to position the inspector close enough to the bridge component so that a "hands-on" inspection can be performed. The following are some of the most common forms of access equipment.

Ladders

Ladders can be used for inspecting the underside of a bridge or for inspecting substructure units. However, a ladder should be used only for those portions of the bridge that can be reached safely, without undue leaning.

Figure 3.5.1 Inspection with a Ladder

Ladders can also be used to climb down to access elements of the bridge. The hook-ladder, as it is commonly referred to, is fastened securely to the bridge framing.

Figure 3.5.2 Use of a Hook-ladder

When using a hook-ladder, the inspector should be tied off to a separate safety line, independent of the ladder.

Rigging

Rigging of a structure consists of cables and platforms. Rigging is used to gain access to floor systems and the bottom of main load carrying members in areas where access by other means is not feasible or where special inspection procedures are required (e.g., nondestructive testing and pin removal). Rigging is often used over water, over busy highways or railroads where sufficient clearance exists. Rigging is a good choice for a load posted bridge that does not have the capacity to support an inspection vehicle.

Figure 3.5.3 Rigging for Substructure Inspection

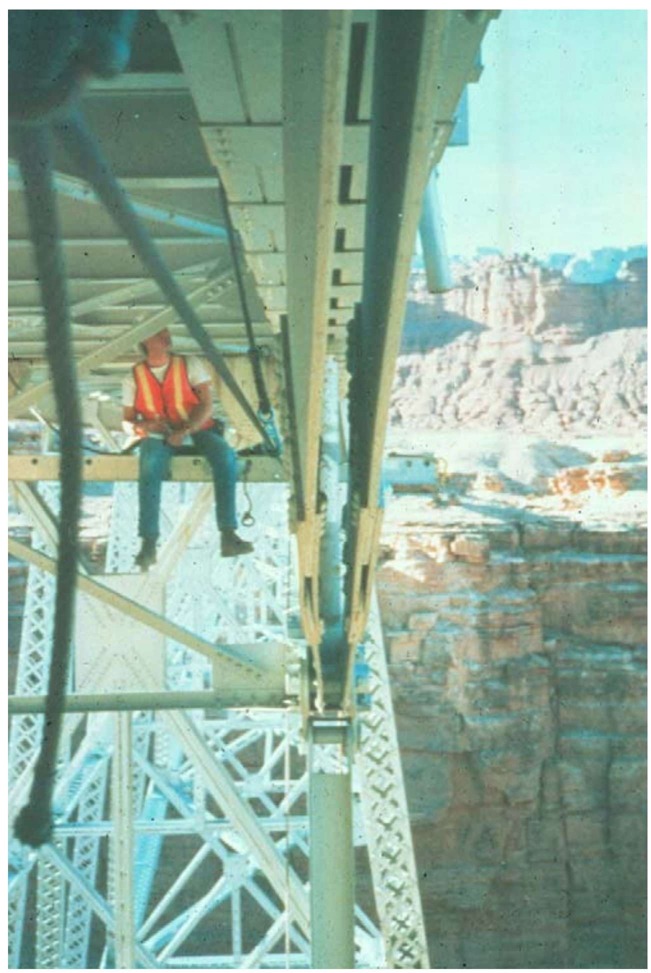


Figure 3.5.4 Rigging for Superstructure Inspection

Scaffolds

They provide an efficient access alternative for structures that are less than 40 feet (12 m) high and over level ground with little or no traffic.

Figure 3.5.5 Scaffold

Boats or Barges

A boat or barge may be needed for structures over water. A boat can be used for some inspection, as well as for taking photographs. Also, a safety boat is required when performing an inspection over water.

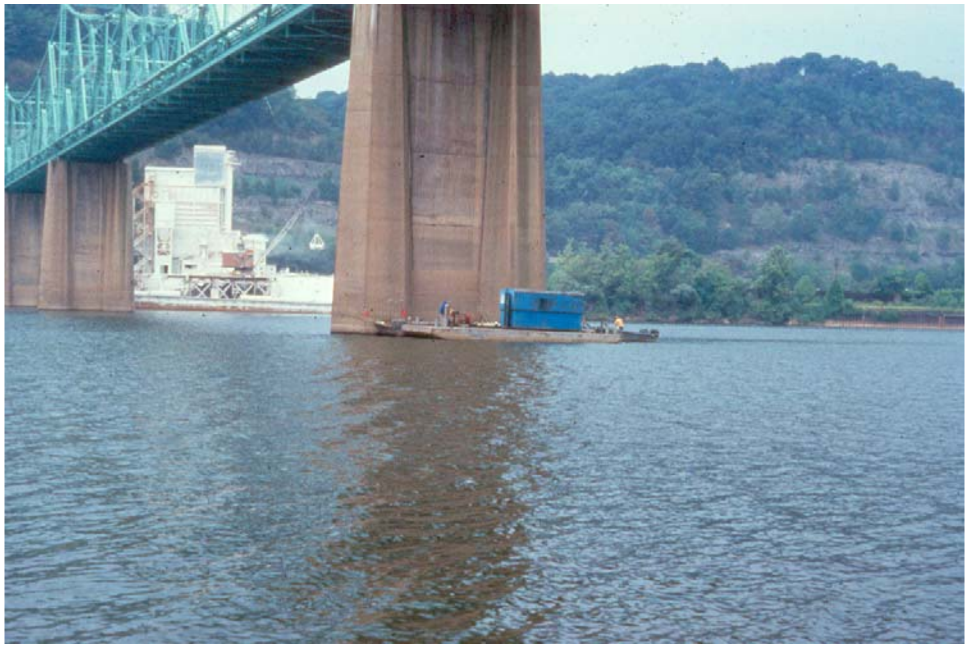


Figure 3.5.6 Inspection Operations from a Barge

A barge may also be used in combination with other access equipment or vehicles to perform an inspection. The barge may be temporarily anchored in place to provide a platform for a manlift or for underwater inspections.

Climbers

Climbers are mobile inspection platforms or cages that "climb" steel cables. They are well suited for the inspection of high piers and other long vertical faces of bridge members. A few of the more common climbers are Spiders and Skyclimbers.

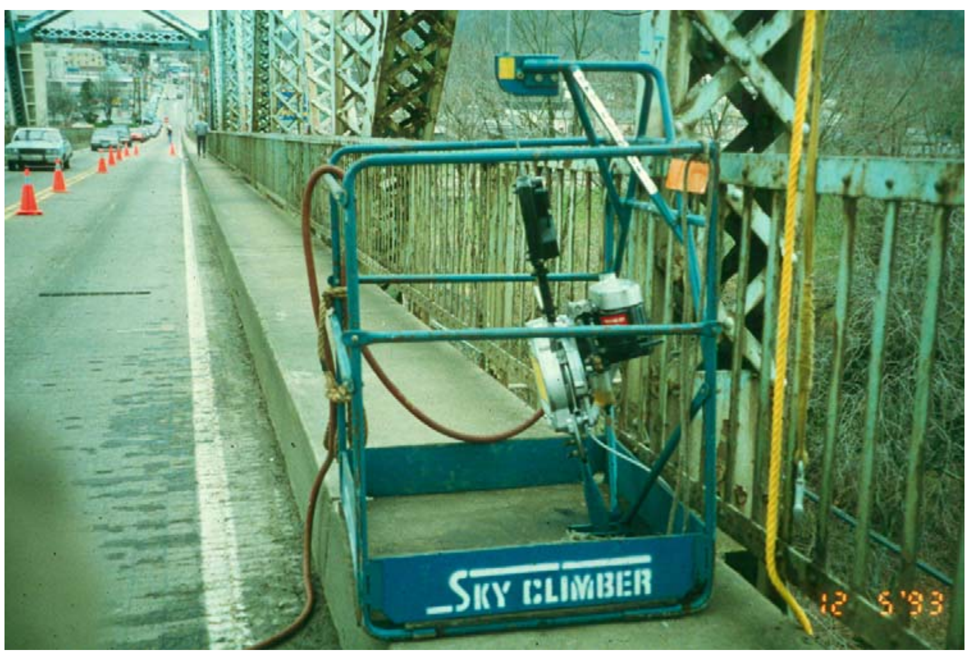


Figure 3.5.7 Climber

Floats

A float is a wood plank work platform hung by ropes. Floats are generally used for access in situations where the inspector will be at a particular location for a relatively long period of time.

Figure 3.5.8 Float

Bosun (or Boatswain) Chairs / Rappelling

Bosun (or boatswain) chairs are suspended with a rope and can carry only one inspector at a time. They can be raised and lowered with block and tackle devices. Rappelling is a similar access method to the Bosun chair but utilizes different equipment and techniques. However, both methods require the use of independent safety lines.

Figure 3.5.9 Bosun Chair

Free Climbing

On some structures, if other methods of access are not practical, inspectors must climb the bridge elements. Safety awareness should be foremost in the inspector's mind when utilizing this technique. Climbing can be divided into two categories. The first category is free climbing, in which the inspector climbs freely, unsecured to the bridge. (Whenever possible, a safety line should be provided for the inspector to secure a lanyard.) The second category employs rappelling techniques and safety equipment.

Figure 3.5.10 Climbing

Permanent Inspection Structures

On some structures, inspection access is included in the design and construction of the bridge. These are typically found on long span structures or more complex designs. Although these inspection platforms only give access to a limited portion of the bridge, they do provide a safe and effective means for the inspector to work. The following are some examples of permanent inspection structures.

Catwalks

A catwalk is an inspection platform typically running parallel to the girders from abutment to abutment under the superstructure. Catwalks can be used to inspect parts of the superstructure and some portions of the substructure. The range of inspection area is limited to those locations near the catwalk.

Figure 3.5.11 Catwalk

Traveler

A traveler is another permanent inspection platform similar to a catwalk except that it is movable. A traveler platform is typically perpendicular to the girders and the platform runs on a rail system between substructure elements. Having the platform perpendicular to the girders allows the inspectors a wider range of movement and enables them to see more if not all of the superstructure elements.

Figure 3.5.12 Traveler Platform

Handrails

Handrails are also used to aid an inspector. Handrails can be used in a number of different locations on the bridge. On the main suspension cables, on top of the pier caps, and on the inside of a girder are just a few locations where handrails may be built. Handrails are typically provided to assist the inspector when free climbing on the bridge and give the inspector a place to secure their lanyard and safety harness.

Figure 3.5.13 Handrail

Inspection Robots

Currently, efforts are being made for robots to be used for inspection purposes. Though still early in the development stage, robots may prove to be an important addition to the inspector's access equipment. Although a robot can never replace a qualified inspector, it can provide information that may not be visible to the human eye. A robot equipped with sonar capabilities can detect internal flaws in bridge members. Also, a robot can be used in situations that are too difficult to reach or extremely dangerous for a human.

3.5.3 Types of Access Vehicles

There are also many types of vehicles available to assist the inspector in gaining access to bridge elements. The following are some of the most common types of access vehicles.

Manlift

A manlift is a vehicle with a platform or bucket capable of holding one or more inspectors. The platform is attached to a hydraulic boom that is mounted on a carriage. An inspector "drives" the carriage using controls in the platform. This type of vehicle is usually not licensed for use on highways. However, some manlifts are nimble and can operate on a variety of terrains. Although four wheel drive models are available, manlifts are limited to use on fairly level terrain. Manlifts come in a number of different sizes with vertical reaches ranging from 12 m (40 feet) to over 52 m (170 feet).

Figure 3.5.14 Manlift **(Note: Adjacent power lines that must be cleared.)**

Bucket Truck

A bucket truck is similar to a manlift. However, a bucket truck can be driven on a highway, and the inspector controls only the bucket. As with the manlift, a bucket truck should be used on fairly level terrain. Bucket trucks have a number of different features and variations:

- Lift capability - varies 7.5 to 15 m (25 to 50 feet).

- Rotating turret - turning range (i.e., the rotational capability of the turret) varies with each vehicle.

- Outriggers - tucket trucks that offer extended reach and turning range have outriggers or supports that are lowered from the chasis of the vehicle to help maintain stability.

- Telescoping toom - some booms may be capable of extending and retracting, providing a greater flexibility and reach area from a given truck location.

- Truck movement - some vehicles offer stable operations without outriggers and can move along the bridge during inspection activities. Vehicles that require outriggers for stable operations cannot be moved during the inspection unless the outriggers have wheels.

- Multiple booms - some bucket trucks have more than one boom, and provide reach up to 15 m (50 feet).

Figure 3.5.15 Bucket Truck

Underbridge Inspection Vehicle

An underbridge inspection vehicle is a specialized bucket truck with an articulated boom designed to reach under a structure while parked on the deck. A rotating turret provides maximum flexibility, and outriggers with wheels allow the truck to be moved during operations. Usually the third boom has the capacity for extending and retracting, allowing for greater reach under a structure. Some of the larger underbridge inspection vehicles have four booms, allowing an even greater reach.

Figure 3.5.16 Underbridge Inspection Vehicle

Many of the features on an underbridge inspection vehicle are standardized on all models. Some of the common features include:

- Rotating turret - provides maximum flexibility.

- Outriggers with wheels - allow for moving the truck during operations.

- Telescoping third boom - usually the third boom has the capability for extending and contracting; this allows for greater reach under a structure.

Variations and options available on different models include:

- Capacity - Some underbridge inspection vehicles have a two or three person bucket on the end of the third boom. Other models are equipped with a multiple-person platform on the third boom with a ladder on the second boom. Still other models may have the capability of interchanging a bucket and a platform in the shop.

- Telescoping second boom - Some underbridge inspection vehicle models have a second boom that can extend and contract, providing greater movement in the vertical direction.

- Articulated third (or fourth) boom - Some underbridge inspection vehicle models have a small third or fourth boom that allows for greater vertical movement under the structure. This option is particularly useful on bridges with deep superstructure members.

Platform Truck

Another underbridge inspection vehicle is a platform truck, which combines the underbridge reach capability of a snooper truck with the freedom of movement of platform rigging. The platform is lowered from the truck to under the bridge by means of an articulated boom, similar to the underbridge inspection crane. The platform can then telescope out to provide inspection access to a wide range of the superstructure and substructure. Outriggers with wheels allow the truck to be moved during operation. The inspector is now free to walk from beam to beam without having to reposition the platform. This combination allows for an efficient and thorough inspection.

Figure 3.5.17 Platform Truck

3.5.4 Method of Access and Cost Efficiency

In most cases, even the most sluggish lift device will be quicker than using a ladder or rigging to inspect a structure. The time saved, however, must offset the high costs associated with obtaining and operating the vehicle.

In assessing the time-saving effectiveness of a lift device, the following questions should be answered:

- Can the bridge be inspected by other reasonable methods?
- What type of vehicle is available?
- How much of the bridge can be inspected using the vehicle?
- How much of the bridge can be inspected from one setup?
- How much time does it take to inspect at each setup?

- How much time does it take to move from one setup to the next?
- Does the vehicle require an operator or driver other than the inspector?
- Will the use of the vehicle require special traffic control?

The inspection time and vehicle costs can then be compared to costs associated with using standard access equipment.

3.5.5 Safety Considerations

Safety should be a primary concern on any job site, not only of the workers but of the public as well. The equipment and vehicles being used also have safety considerations.

Access Equipment

Before the bridge inspection begins, an equipment inspection should be performed. As a minimum, inspect access equipment as per the manufacture's guidelines. Using faulty equipment can lead to serious accidents and even death. The inspector should check all the equipment and verify that it is in good working condition with no defects or problems. If rigging or scaffolding is being used, it should be checked to ensure that it was installed properly and all cables and planks are secured tightly. When climbing, check for loose clothing or articles that can get caught. OSHA-approved safety harnesses with shock absorbing lanyards should be worn at all time when using access equipment and vehicles.

Access Vehicles

If the inspector is not familiar with the inspection vehicle being used, he should take the time required to become accustomed to the operation. In some cases, formal operator training may be necessary or required. When operating any inspection vehicle, always be aware of any overhead power lines or any other hazards that may exist. It is also important to be aware of any restrictions on the vehicle, such as weight limits for the bucket, support surface slope limits, and reach restrictions, so as to avoid situations that will cause accidents. Always be alert to your location also. You do not want to boom out into an unprotected traffic lane or near electrical lines.

Table of Contents

Section 4
Bridge Inspection
Reporting System

This page intentionally left blank

Section 4

Bridge Inspection Reporting System

Topic 4.1 Structure Inventory

4.1.1 Introduction

A good bridge inspection reporting system is essential to document bridge conditions and to protect the public's safety and investment in bridge structures. It is, therefore, essential that bridge inspection data be clear, accurate, and complete, since it is an integral part of the lifelong record file of the bridge.

Because of the requirements that must be fulfilled for the National Bridge Inspection Standards (NBIS), it is necessary to employ a uniform bridge inspection reporting system. A uniform reporting system is essential to evaluate the condition of a structure correctly and efficiently. It is a valuable aid in establishing maintenance priorities and replacement priorities, and in determining structure capacity and the cost of maintaining the nation's bridges. Consequently, importance of the reporting system cannot be overemphasized. Success of any bridge inspection program is dependent upon its reporting system.

4.1.2 FHWA Structure Inventory, Appraisal and Condition Ratings

The FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (*Coding Guide*) is used for establishing the bridge inventory and the overall condition of the deck, superstructure, substructure, and channel. It is not an inspection guide. Each state is encouraged to use codes and instructions in the *Coding Guide*, but its direct use is optional. Each state may use its own coding scheme, provided that the data is directly translatable into the format of the *Coding Guide*. In other words, the states are responsible for having the capability to obtain, store, and report certain information about bridges, whether or not the *Coding Guide* is used by the inspectors.

The Structure Inventory and Appraisal (SI&A) sheet is a tabulation of information that must be submitted for each individual structure (see Figure 4.1.1). Any requests by the FHWA for submittals of SI&A data will be based on the definitions, explanations, and codes supplied in this manual, its supplements, and the *Coding Guide*.

Sometimes inventory data is not available for new or small bridges and culverts.

For the small bridges and culverts that are less than 20 feet, some states still collect the inventory information and generate a "local" database. The inspector must gather enough information in order to establish inventory data.

It is important to note that the SI&A sheet is not an inspection form. Rather, it is a summary sheet of bridge data required by the FHWA to effectively monitor and manage the National Bridge Inspection Program and the Highway Bridge Replacement and Rehabilitation Program.

Substitutes for the SI&A Sheet

NBIS allows the use of suitable substitutes for the SI&A sheet. The only requirement is that the forms must be standardized. Some states simply reprint the federal form with the same items and item numbers. A few states have elaborate Bridge Management Systems (BMS) with different item numbers that collect all the data listed on the SI&A form plus additional items not reported to the FHWA (see Figures 4.1.1, 4.1.2 and 4.1.3).

FHWA | *Office of Asset Management DOT*

Structure Inventory and Appraisal Sheet

Bridge Key: 11 0013 | Agency ID: 11 0013 | Sufficiency Rating: 96.8

IDENTIFICATION

State 1:	06 California	Struc Num 8:	11 0013
Facility Carried 7:	STATE ROUTE 162	Location 9:	03-GLE-162-_-73.55
Rte.(On/Under)5A:	Route On Structure	Rte. Signing Prefix 5B:	3 State Hwy
Level of Service 5C:	1 Mainline	Rte. Number 5D:	00162
Directional Suffix 5E:	0 N/A (NBI)	% Responsibility :	Unknown
SHD District 2:	District 3	County Code 3:	(11)GLENN
Place Code 4:	Unknown	Kilometer Post 11:	73.6 km
Feature Intersected 6:	BRUSH CANAL		
Latitude 16:	39d 31' 18"	Longitude 17:	122d 03' 42"
Border Bridge Code 98:	Unknown (P)		
Border Bridge Number 99:	Unknown		

STRUCTURE TYPE AND MATERIALS

Number of Approach Spans 46: 0 | Number of Spans Main Unit 45: 2

Main Span Material/Design 43A/B:

2 Concrete Continuous | 01 Slab

Deck Type 107:	1 Concrete-Cast-in-Place
Wearing Surface 108A:	1 Monolithic Concrete
Membrane 108B:	0 None
Deck Protection 108C:	None

AGE AND SERVICE

Year Built 27:	1963	Year Reconstructed 106:	Unknown		
Type of Service on 42A:	1 Highway				
Type of Service under 42B:	5 Waterway				
Lanes on 28A:	2	Lanes Under 28B:	0	Detour Length 19:	13 km
ADT 29:	1,900	Truck ADT 109:	12 %	Year of ADT 30:	1994

GEOMETRIC DATA

Length Max Span 48:	6.40 m	Structure Length 49:	13.70 m
Curb/Sdwlk Wdth L 50A:	0.00 m	Curb/Sidewalk Width R 50B:	0.00 m
Width Curb to Curb 51:	10.80 m	Width Out to Out 52:	11.30 m
Approach Roadway Width 32: (w/ shoulders)	9.80 m	Median 33:	0 No median
Deck Area:	155.00 m²		
Skew 34:	5.00 °	Structure Flared 35:	0 No flare
Minimum Vertical Clearance Over Bridge 53:			99.99 m
Minimum Vertical Underclearance Reference 54A:			N Feature not hwy or RR
Minimum Vertical Underclearance 54B:			00.00 m
Minimum Lateral Underclearance Reference R 55A:			N Feature not hwy or RR
Minimum Lateral Undrclearance R 55:			99.90 m
Minimum Lateral Undrclearance L 56:			00.00 m

INSPECTION

Frequency 91:	24 months	Inspection Date 90:	10/28/1997	Next Inspection:	10/28/1999
FC Frequency 92A:	NA	FC Inspection Date 93A:	NA	Next FC Inspection:	NA
UW Frequency 92B:	NA	UW Inspection Date 93B:	NA	Next UW Inspection:	NA
SI Frequency 92C:	NA	SI Date 93C:	NA	Next SI:	NA
Element Frequency:	24 months	Element Inspection Date:	12/11/1997	Next Elem. Insp. Due:	10/28/1999

CLASSIFICATION

Defense Highway 100:	0 Not a STRAHNET hwy	Parallel Structure 101:	No || bridge exists
Direction of Traffic 102:	2 2-way traffic	Temporary Structure 103:	Unknown (NBI)
Highway System 104:	0 Not on NHS	NBIS Length 112:	Long Enough
Toll Facility 20:	3 On free road	Functional Class 26:	06 Rural Minor Arterial
Historical Significance 37:	5 Not eligible for NRHP		
Owner 22:	1 State Highway Agency		
Custodian 21:	1 State Highway Agency		

CONDITION

Deck 58:	7 Good	Super 59:	7 Good	Sub 60:	7 Good
Culvert 62:	N N/A (NBI)	Channel/Channel Protection 61:	8 Protected		

LOAD RATING AND POSTING

Inventory Rating Method 65:	1 LF Load Factor	Operating Rating Method 63:	1 LF Load Factor
Inventory Rating 66:	MS20.7	Operating Rating 64:	MS34.2
Design Load 31:	5 MS 18 (HS 20)	Posting 70:	5 At/Above Legal Loads
Posting status 41:	A Open, no restriction		

APPRAISAL

Bridge Rail 36A:	1 Meets Standards	Approach Rail 36C:	0 Substandard
Transition 36B:	0 Substandard	Approach Rail Ends 36D:	0 Substandard
Str. Evaluation 67:	7 Above Min Criteria	Deck Geometry 68:	6 Equal Min Criteria
Underclearance, Vertical and Horizontal 69:	N Not applicable (NBI)		
Waterway Adequacy 71:	8 Equal Desirable	Approach Alignment 72:	8 Equal Desirable Crit
Scour Critical 113:	6 Calcs not made		

PROPOSED IMPROVEMENTS

Bridge Cost 94:	$ 0	Type of Work 75:	Unknown (P)
Roadway Cost 95:	$ 0	Length of Improvment 76:	00.00 m
Total Cost 96:	$ 0	Future ADT 114:	2,900
Year of Cost Estimate 97:	Unknown	Year of Future ADT 115:	2010

NAVIGATION DATA

Navigation Control 38:	0 Permit Not Required		
Vertical Clearance 39:	0.00 m	Horizontal Clearance 40:	0.00 m
Pier Protection 111:	Unknown (NBI)	Lift Bridge Vertical Clearance 116:	

ELEMENT CONDITION STATE DATA

Str Unit	Elm/Env	Description	Units	Total Qty	% in 1	Qty. St. 1	% in 2	Qty. St. 2	% in 3	Qty. St. 3	% in 4	Qty. St. 4	% in 5	Qty. St. 5
2	38/2	Bare Concrete Slab	sq.m.	160	100 %	160	0 %	0	0 %	0	0 %	0	0 %	0
2	205/2	R/Conc Column	ea.	5	100 %	5	0 %	0	0 %	0	0 %	0	0 %	0
2	215/2	R/Conc Abutment	m.	23	100 %	23	0 %	0	0 %	0	0 %	0	0 %	0
2	226/2	P/S Conc Submgd Pile	ea.	13	100 %	13	0 %	0	0 %	0	0 %	0	0 %	0
2	333/2	Other Bridge Railing	m.	35	100 %	35	0 %	0	0 %	0	0 %	0	0 %	0
2	358/2	Deck Cracking SmFlag	ea.	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0

INSP001_Inspection_SIA_Metric | **Mon 6/10/2002 07:54:09 Page 1 of 1**

Figure 4.1.1 FHWA SI&A Sheet with Element Level Data

Appendix A

OMB No. 2125-0501

Structure Inventory and Appraisal Sheet

NATIONAL BRIDGE INVENTORY - - - - - - - STRUCTURE INVENTORY AND APPRAISAL 10/15/94

********** IDENTIFICATION **********************
(1) STATE NAME - ___________ CODE ___
(8) STRUCTURE NUMBER #_____________
(5) INVENTORY ROUTE (ON/UNDER) - _____ = ________
(2) HIGHWAY AGENCY DISTRICT __
(3) COUNTY CODE ___ (4) PLACE CODE _____
(6) FEATURES INTERSECTED - ________________
(7) FACILITY CARRIED - ____________
(9) LOCATION - ________________
(11) MILEPOINT/KILOMETERPOINT ___.___
(12) BASE HIGHWAY NETWORK - _______ CODE _
(13) LRS INVENTORY ROUTE & SUBROUTE #__________
(16) LATITUDE __ DEG __ MIN __.__ SEC
(17) LONGITUDE __ DEG __ MIN __.__ SEC
(98) BORDER BRIDGE STATE CODE ___ % SHARE __ %
(99) BORDER BRIDGE STRUCTURE NO. #___________

********** STRUCTURE TYPE AND MATERIAL *********
(43) STRUCTURE TYPE MAIN: MATERIAL - __________
TYPE - ______________ CODE ___
(44) STRUCTURE TYPE APPR: MATERIAL - __________
TYPE - ______________ CODE ___
(45) NUMBER OF SPANS IN MAIN UNIT ___
(46) NUMBER OF APPROACH SPANS ___
(107) DECK STRUCTURE TYPE - __________ CODE _
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - ________ CODE _
B) TYPE OF MEMBRANE - ________ CODE _
C) TYPE OF DECK PROTECTION - ________ CODE _

********** AGE AND SERVICE *********************
(27) YEAR BUILT ____
(106) YEAR RECONSTRUCTED ____
(42) TYPE OF SERVICE: ON - ______________
UNDER - ______________ CODE __
(28) LANES: ON STRUCTURE __ UNDER STRUCTURE __
(29) AVERAGE DAILY TRAFFIC ______
(30) YEAR OF ADT ____ (109) TRUCK ADT __ %
(19) BYPASS, DETOUR LENGTH ___ KM

********** GEOMETRIC DATA **********************
(48) LENGTH OF MAXIMUM SPAN ____._ M
(49) STRUCTURE LENGTH ____._ M
(50) CURB OR SIDEWALK: LEFT __._ M RIGHT __._ M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB ___._ M
(52) DECK WIDTH OUT TO OUT ___._ M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) ___._ M
(33) BRIDGE MEDIAN - ____________ CODE _
(34) SKEW __ DEG (35) STRUCTURE FLARED _
(10) INVENTORY ROUTE MIN VERT CLEAR __.__ M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR ___._ M
(53) MIN VERT CLEAR OVER BRIDGE RDWY __.__ M
(54) MIN VERT UNDERCLEAR REF - _______ __.__ M
(55) MIN LAT UNDERCLEAR RT REF - _______ __._ M
(56) MIN LAT UNDERCLEAR LT __._ M

********** NAVIGATION DATA *********************
(38) NAVIGATION CONTROL - ____________ CODE _
(111) PIER PROTECTION - ____________ CODE _
(39) NAVIGATION VERTICAL CLEARANCE ___._ M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR ___._ M
(40) NAVIGATION HORIZONTAL CLEARANCE ____._ M

****

SUFFICIENCY RATING = ____._
STATUS = ______________

********** CLASSIFICATION ***************** CODE
(112) NBIS BRIDGE LENGTH - __
(104) HIGHWAY SYSTEM - ______________ _
(26) FUNCTIONAL CLASS - ______________ _
(100) DEFENSE HIGHWAY - ______________ _
(101) PARALLEL STRUCTURE - ______________ _
(102) DIRECTION OF TRAFFIC - ______________ _
(103) TEMPORARY STRUCTURE - ______________ _
(105) FEDERAL LANDS HIGHWAYS - ______________ _
(110) DESIGNATED NATIONAL NETWORK - __________ _
(20) TOLL - ______________ _
(21) MAINTAIN - ______________ _
(22) OWNER - ______________ __
(37) HISTORICAL SIGNIFICANCE - __________ _

********** CONDITION ********************** CODE
(58) DECK _
(59) SUPERSTRUCTURE _
(60) SUBSTRUCTURE _
(61) CHANNEL & CHANNEL PROTECTION _
(62) CULVERTS _

********** LOAD RATING AND POSTING ******** CODE
(31) DESIGN LOAD - _______ OR _______ _
(63) OPERATING RATING METHOD - __________ _
(64) OPERATING RATING - _______ __._
(65) INVENTORY RATING METHOD - __________ _
(66) INVENTORY RATING - _______ __._
(70) BRIDGE POSTING - ______________ _
(41) STRUCTURE OPEN, POSTED OR CLOSED - _
DESCRIPTION - ______________

********** APPRAISAL ********************** CODE
(67) STRUCTURAL EVALUATION _
(68) DECK GEOMETRY _
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL _
(71) WATERWAY ADEQUACY _
(72) APPROACH ROADWAY ALIGNMENT _
(36) TRAFFIC SAFETY FEATURES ___
(113) SCOUR CRITICAL BRIDGES _

********** PROPOSED IMPROVEMENTS ***************
(75) TYPE OF WORK - ______________ CODE ___
(76) LENGTH OF STRUCTURE IMPROVEMENT _____._ M
(94) BRIDGE IMPROVEMENT COST $___,___,000
(95) ROADWAY IMPROVEMENT COST $___,___,000
(96) TOTAL PROJECT COST $___,___,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE ____
(114) FUTURE ADT ______
(115) YEAR OF FUTURE ADT ____

********** INSPECTIONS ************************
(90) INSPECTION DATE __/__ (91) FREQUENCY __ MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL - __ - __ MO A) __/__
B) UNDERWATER INSP - __ - __ MO B) __/__
C) OTHER SPECIAL INSP - __ - __ MO C) __/__

Figure 4.1.2 FHWA SI&A Sheet with NBI Data Only

Printed: 5/15/2000 | ARIZONA DEPARTMENT OF TRANSPORTATION | Page 1 of 1

BRIDGE GROUP

Structure Inventory & Appraisal

Structure Number: 4023	Structure Name: RCB		Feature Under: WASH
Route: 60 MP 56.85	Road Name: US 60	Agency: ADOT	Location: 7.3 M E JCT SR 72

LOCATION INFORMATION

N1-State Code:	049
N2-State Hwy District:	88
N3-County Code:	029
N4-Place Code:	00000
N16-Latitude:	33 deg 47.1 min
N17-Longitude:	113 deg 36.5 min
N98-Border St Code - % Resp:	- 0
N99-Border Bridge Number:	

INVENTORY ROUTE DATA

N19-Detour Length (miles):	20	
N20-Toll:	3	
N28-Lanes On / Under:	2 / 0	
		2nd Record
N5-Inv Rte:	1 2 0 00060 0 -	
N10-Inv Rte Min Vert Clr (feet):	99.99	0
N11-Inv Rte Milepoint:	56.85	0
N26-Functional Class:	07	
N29-Avg Daily Traffic:	2417	0
N30-Year of ADT:	1998	
N47-Inv Rte Tot Horiz Clr (feet):	39	0
N100-Defense Hwy:	0	
N101-Parallel Bridge:	N	
N102-Direction of Traffic:	2	
N104-Hwy System:	0	
N109-Percent Truck Traffic:	46	0
N110-National Truck Network:	1	
N114-Future ADT:	2427	0
N115-Year of Future ADT:	2020	
N200-Is N5 the Princ. Rte?	Y	N

RESPONSIBILITY

N21-Maint Responsibility:	01
N22-Bridge Owner:	01
A203-ADOT Org Number:	8852
A224-Insp Team Number:	4
A229-Agency:	ADOT

NAVIGATION

N38-Navigation Control:	0
N39-Nav Vert Clr (feet):	0
N40-Nav Horiz Clr (feet):	0
N111-Nav Pier/Abut Prot:	
N116-Nav Min Vert Clr (feet):	0

GENERAL DATA

N33-Bridge Median:	0
N34-Skew:	0
N35-Structure Flared:	0
N37-Historical Significance:	5
N107-Deck Str Type:	1
N108-Wear Surf Prot System:	6 0 0
A201-Wear Surf Thickness (inches):	4

DIMENSIONS

N32-Appr Rdwy Width (feet):	36
N48-Max Span Length (feet):	10
N49-Structure Length (feet):	32
N50a-Lt Curb/Swlk Width (feet):	1
N50b-Rt Curb/Swlk Width (feet):	1
N51-Br Width Curb-Curb (feet):	39
N52-Deck Width Out-Out (feet):	41.6
N112-NBIS Br Length?	Y

VERTICAL and HORIZONTAL CLEARANCE

N53-Min Vert Over Clr (feet):	99.99
N54-Min Vert Under Clr (feet):	N 0
N55-Min Lat Under Clr Rt (feet):	N 99.9
N56-Min Lat Under Clr Lt (feet):	0

SERVICE, TYPE, and SPAN INFORMATION

N42-Service Type:	1 5
N43-Str Type, Main:	2 19
N44-Str Type, Appr:	0 00
N45-Number of Main Spans:	3
N46-Number of Appr Spans:	0

CONDITION RATINGS

N58-Deck:	8
N59-Superstructure:	N
N60-Substructure:	N
N61-Channel:	7
N62-Culvert:	7

APPRAISAL RATINGS

N67-Struct Evaluation:	7
N68-Deck Geometry:	5
N69-Underclearance Rtg:	N
N71-Waterway Adequacy:	6
N72-Appr Rdw Align:	8
N36-Traffic Safety Features:	0 0 0 0

BRIDGE SCOUR DATA

N113-Scour Critical Rtg:	8
A202-Foundation Type:	
A220-Found Embed (feet):	0
A221-Scour Countermeasure:	0 1 0

LOAD, RATE, and POST

N31-Design Loading:	5
N41-Open, Post, Close:	A
N63-Method Used for Oper. Rtg.:	5
N64-Operating Load Rtg:	2 - 36
N65-Method Used for Inv. Rtg.:	5
N66-Inventory Load Rtg:	2 - 36
N70-Bridge Posting:	5
N103-Temp Str Designation:	
A211-Posted Limit (Tons):	0
A222-Date of Load Rtg:	
A233-Posted Vert Clr NB/EB (ft-in):	0 - 0
A233-Posted Vert Clr SB/WB (ft-in):	0 - 0

PROPOSED IMPROVEMENTS

N75-Type of Work:	
N76-Length of Str Imp (feet):	0
N94-Br Improv Cost (x1000):	$0
N95-Rdwy Improv Cost (x1000):	$0
N96-Total Project Cost (x1000):	$0
N97-Year of Cost Estimate:	

CONSTRUCTION PROJECT DATA

N27-Year Built:	1958
N106-Year of Reconstruction:	0000
A204-Orig Project Number:	F-022-1(1)
A205-Orig Project Station:	3045+14.34
A223-TRACS Number:	
A225-Deck Area (sq. feet):	0
A226-Superstr Unit Cost:	$0
A227-Substr Unit Cost:	$0

INSPECTION

N90-Inspection Date:	2/1/2000
N91-Insp Freq (months):	48
A207-Inspection Quarter:	1
A208-Inspection Number:	14
A228-Next Insp Date:	Quarter 1, 2004

CRITICAL FEATURES

N92A-Fracture Critical:	N 0
N92B-Underwater Insp:	N 0
N92C-Special Insp:	N 0
N93A-Date Fract Crit Insp:	0
N93B-Date Underwtr Insp:	0
N93C-Date Spec Insp:	0
A234-Steel In-Depth Insp Freq (mo):	0

CULVERT INFORMATION

A217-Culv Barrel Height (feet)	6
A218-Culv Length (feet):	41
A219-Culv Fill Height (feet):	1

BRIDGE RAILING

A206a-Bridge Rail Type:	6
A206b-Geometric Conform:	0
A206c-Structural Conform:	0

SUFFICIENCY RATING

Sufficiency Rating: 92.32

GENERAL COMMENTS

Figure 4.1.3 Arizona Structural Inventory and Appraisal Sheet

REPORT ID: INVT001A

FLORIDA DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SYSTEM
COMPREHENSIVE INVENTORY DATA REPORT

Page 1 of 4
DATE PRINTED: 11/14/2000 13:43

Structure ID: 520002

4 Description

Structure Unit Identification

Bridge/Unit ID 520002 0
Description MAIN SPAN 1
Type Main Span
NBI Unit Flag Main ✓ Approach ☐
Curb/Sidewalk (50) Left 0 ft Right 0 ft
Deck width (52) 0 ft
Bridge Median (33) No median

Structure Unit Type and Material

Struct Material (43) Concrete
Design Type Culvert
Deck Type (107) Not Applicable
Surface (108) Not Applicable
Membrane None
Deck Protection None
Skew (34) 0 deg

Roadway Identification:

NBI Structure No (8) 520002
Position/Prefix (5) Route On Structure
Kind Hwy (Rte Prefix) U.S. Numbered Hwy
Design Level of Service Mainline
Route Number/Suffix 00090 / Not Applicable
Feature Intersect (6) US90 SR10/GUM CREEK
Critical Facility Not Defense-crit
Facility Carried (7) US 90 SR 10
Mile Point (11) 20.815
Latitude (16) 030d47'39" Long (17) 085d43'28"

Roadway Traffic and Accidents

Lanes (28) 2 Medians 0 Speed 54.681 mph
ADT Class ADT Class 3
Recent ADT (29) 5100 Year (30) 1998
Future ADT (114) 9490 Year (115) 2020
Truck % ADT (109) 7
Detour Length (19) 1.243 mi
Detour Speed 44.739 mph
Accident Count -1 Rate -1

Roadway Classification

Nat. Hwy Sys (104) Not on NHS
National base Net (12) On Base Network
LRS Inventory Rte (13a) 52 010 000 Sub Rte (13b) 00
Functional Class (26) Rural Minor Arterial
Eligible for Federal Aid ? Yes
Defense Hwy (100) Not a STRAHNET hwy
Direction of Traffic (102) 2-way traffic
Critical Travel Route ☐

Roadway Clearances

Vertical (10) 99.99 ft Appr. Road (32) 34.121 ft
Horiz. (47) 34.121 ft Roadway (51) 0 ft
Truck Network (110) Not part of natl network
Toll Facility (20) On free road
Fed. Lands Hwy (105) Not Applicable
School Bus Route ☐
Transit Route ☐

Figure 4.1.4 Florida Structural Inventory and Appraisal Sheet

REPORT ID: INVT001A

FLORIDA DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SYSTEM
COMPREHENSIVE INVENTORY DATA REPORT

Page 2 of 4
DATE PRINTED: 11/14/2000 13:43

Structure ID: 520002

Structure Identification

Admin Area	Not located in area
District (2)	D3 - Chipley
County (3)	(52)Holmes
Place Code (4)	No city involved
Location (9)	3.2 KM W OF BONIFAY
Border Br St/Reg (98)	Not Applicable Share 0 %
Border Struct No (99)	
FIPS State/Region (1)	Florida Region 4-Atlanta
NBIS Bridge Len (112)	Meets NBI Length
Parallel Structure (101)	No ll bridge exists
Temp. Structure (103)	Not Applicable
Maint. Resp. (21)	State Highway Agency
Owner (22)	State Highway Agency
Historic Signif. (37)	Not eligible for NRHP

Geometrics

Spans in Main Unit (45)	4
Approach Spans (46)	0
Length of Max Span (48)	9.843 ft
Structure Length (49)	42.979 ft
Deck Area	-1 sqft
Structure Flared (35)	No flare

Age and Service

Year Built (27)	1954
Year Reconstructed (106)	-1
Type of Service On (42a)	Highway
Under (42b)	Waterway
Fracture Critical Details	Not Applicable

3 Appraisal

Structure Appraisal

Open/Posted/Closed (41)	Open, no restriction
Deck Geometry (68)	Not Applicable
Underclearances (69)	Not Applicable
Approach Alignment (72)	No speed red thru curve
Bridge Railings (36a)	Not Applicable
Transitions (36b)	Not Applicable
Approach Guardrail (36c)	Meets Standards
Approach Guardrail ends (36d)	Meets Standards
Scour Critical (113)	Stable Above Footing

Navigation Data

Navigation Control (38)	Permit Not Required
Nav Vertical Clr (39)	0 ft
Nav Horizontal Clr (40)	0 ft
Min Vert Lift Clr (116)	0 ft
Pier Protection (111)	Not Applicable

NBI Condition Rating

Sufficiency Rating	* 99.5
Structural Eval (67)	Above Min Criteria
Deficiency	Not Deficient

Minimum Vertical Clearance

Over Structure (53)	99.99 ft
Under (reference) (54a)	Feature not hwy or RR
Under (54b)	0 ft

Minimum Lateral Underclearance

Reference (55a)	Feature not hwy or RR
Right Side (55b)	0 ft
Left Side (56)	0 ft

Load Rating

Design Load (31)	M 13.5 (H 15)
Rating Date	08/08/1994 Initials JF
Posting (70)	At/Above Legal Loads

Operating Type (63)	LF Load Factor	
Operating rating (64)	68.894 tons	Alternate -1
Inventory Type (65)	LF Load Factor	
Inventory Rating (66)	40.896 tons	Alternate -1
		Alt Meth -1

6 Schedule

Current Inspection

Inspection Date	01/06/2000
Inspector	MT338TK - Tom Klopfenstein
Primary Type	Regular NBI
Review Required	☐

Next Inspection Date **Scheduled**

NBI	01/06/2002
Element	01/06/2002
Fracture Critical	
Underwater	
Other Special	

Inspection Types Performed   NBI ☑   Element ☑   Fracture Critical ☐   Underwater ☐   Other Special ☐

Figure 4.1.4 Florida Structural Inventory and Appraisal Sheet (Continued)

REPORT ID: INVT001A

FLORIDA DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SYSTEM
COMPREHENSIVE INVENTORY DATA REPORT

Page 3 of 4

DATE PRINTED: 11/14/2000 13:43

Structure ID: 520002

Inspection Intervals	Required (92)	Frequency (92)		Last Date (93)	Inspection Resources	
Fracture Critical	☐	mos			Crew Hours	8
Underwater	☐	mos			Flagger Hours	0
Other Special	☐	mos			Helper Hours	0
NBI		24 mos	(91)	01/06/2000 (90)	Snooper Hours	0
					Special Crew Hours	0
					Special Equip Hours	0

5 Custom

General Bridge Information

Parallel Bridge Seq		Bridge Rail 1	Not applicable-No rail
Channel Depth	0.328 ft	Bridge Rail 2	Not applicable-No rail
Radio Frequency	-1	Electrical Devices	No electric service
Phone Number	(000) 000-0001	Culvert Type	Not applicable
Exception Date		Maintenance Yard	Marianna Yard
Exception Type	Unknown		

Bridge Load Rating Information

Govr. Span Length	9.843 ft	Single Unit Truck 2 Axles	48.502 tons
L-Rating Origination	Design Plans	Single Unit Truck 3 Axles	60.627 tons
Load Rating Date	08/08/1994	Single Unit Truck 4 Axles	74.957 tons
Method Calculation	AASHTO formula	Combination Unit Truck 3 Axles	79.366 tons
Load Dist. Factor	0.168	Combination Unit Truck 4 Axles	79.366 tons
Impact Factor	0	Combination Unit Truck 5 Axles	87.083 tons
Design Method	Load Factor	Truck Trailer 5 Axles	95.901 tons
Design Measure	English	Posting Weight	tons
Recommended Single Unit	-1 tons	Posting Single Unit	-1 tons
Recommended Combination	-1 tons	Posting Combination Unit	-1 tons
Recommended Tandem	-1 tons	Posting Tandem Unit	-1 tons

Bridge Scour and Storm Information

Pile Driving Record	Not Applicable	Scour Recommended I	Stop scour evaluations
Foundation Type	Foundation details	Scour Recommended II	Unknown
Mode of Flow	Riverine	Scour Recommended III	Unknown
Rating Scour Eval	Low Risk - Low	Scour Elevation	-1 ft
Highest Scour Eval	Phase I completed	Action Elevation	-1 ft
		Storm Frequency	-1

1 Condition

NBI Rating

Channel (61)	No Deficiencies	Culvert (62)	Minor Deterioration
Deck (58)	Not Applicable	Waterway (71)	8 - Equal Desirable
Superstructure (59)	Not Applicable	Unrepaired Spalls	-1 sq.ft.
Substructure (60)	Not Applicable	Review Required	☐

Figure 4.1.4 Florida Structural Inventory and Appraisal Sheet (Continued)

REPORT ID: INVT001A

FLORIDA DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SYSTEM
COMPREHENSIVE INVENTORY DATA REPORT

Page 4 of 4
DATE PRINTED: 11/14/2000 13:43

Structure ID: 520002

Elements

Inspection Date: 01/06/2000 GKXW

Span Id	Elem/En	Description	Qty1	%1	Qty2	%2	Qty3	%3	Qty4	%4	Qty5	%5	T Qty
0	290/4	Channel	1	100	0	0	0	0	0	0	0	0	1 ea.
Notes													
0	475/4	R/Conc Walls	154	100	0	0	0	0	0	0	0	0	154 lf.
Notes													
0	241/4	Concrete Culvert	299	82	66	18	0	0	0	0	0	0	364 lf.
Notes	There are a few vertical cracks in the side walls of the original section of culvert.												

Total Number of Elements: 3

Past Inspections

Inspection Date: 01.06.2000 Type: Regular NBI
Inspector: MT338TK - Tom Klopfenstein

Inspection Notes: Sufficiency Rating Calculation Accepted by mt338tk at 01/10/2000 13:45:43
MT338TK inspection comments - The left extended portion of culvert is skewed 24 degrees to the left due to stream alignment.
Structure 520002 -
Date 01/06/2000 -
Previous comments > (none)

Inspection Date: 04.01.1998 Type: Regular NBI
Inspector: BID

Inspection Notes:

Bridge Notes

Figure 4.1.4 Florida Structural Inventory and Appraisal Sheet (Continued)

Some agencies furnish standardized sketch sheets and photo sheets to inspectors for report generation. Some agencies have developed their forms on software packages for use on portable computers or wearable computers (see Figures 4.1.5 and 4.1.6).

Figure 4.1.5 Wearable Computer with Case

Figure 4.1.6 Inspector Using Wearable Computer

The data and information required of states by the FHWA is listed on the SI&A sheet. It is important to note that the items listed on this sheet apply to both the field and office personnel responsible for bridge inspections. The bridge inspector is not required to obtain the data for all the items during every inspection of a bridge. Once a bridge has been inventoried, the majority of the SI&A items will remain unchanged. The inspector should spot check to see if inventoried items are consistent with findings from the bridge site.

4.1.3 Inventory Items

Inventory items pertain to a bridge's characteristics. For the most part, these items are permanent characteristics, which only change when the bridge is altered in some way, such as reconstruction or load restriction. Inventory items are grouped as follows:

- Identification - identifies the structure using location codes and descriptions.
- Structure Type and Material - categorizes the structure based on the material, design and construction, the number of spans, and wearing surface.
- Age and Service - information showing when the structure was constructed or reconstructed, features the structure carries and crosses, and traffic information.
- Geometric Data - includes pertinent structural dimensions.
- Navigation Data - identifies the existence of navigation control, pier protection, and waterway clearance measurements.
- Classification - classification of the structure and the facility carried by the structure are identified.

- Load Rating and Posting - identifies the load capacity of the bridge and the current posting status.
- Proposed Improvements - items for work proposed and estimated costs for all bridges eligible for funding from the Highway Bridge Replacement and Rehabilitation Program, and other structures the highway agency chooses to include.
- Inspection - includes latest inspection dates, designated frequency, and critical features requiring special inspections or special emphasis during inspection.

All inventory items are explained in the *Coding Guide*. Although inventory items are usually provided from previous reports, the inspector must be able to verify and update the inventory data needed. See Topic 4.2 for condition and appraisal rating items.

4.1.4 Appraisal Items

Appraisal items are a judgment of a bridge component condition in comparison to current standards. Appraisal items are used to evaluate the structure based on the level of service it provides on the highway system. Appraisal rating items include the following SI&A items:

- Structural Evaluation – Overall condition of the structure based on all major deficiencies, and its ability to carry loads.
- Deck Geometry – Evaluates the curb-to-cub bridge roadway width and the minimum vertical clearance over the bridge roadway.
- Under-clearances, Vertical and Horizontal – The vertical and horizontal under-clearances from the through roadway under the structure to the superstructure or substructure units.
- Waterway Adequacy – Appraises waterway opening with respect to passage of flow under the bridge.
- Approach Roadway Alignment – Comparing the alignment of the bridge approaches to the general highway alignment of the section of highway that the structure is on.
- Traffic Safety Features – Record information on bridge railings, transitions, approach guiderail, approach guiderail ends, so that evaluation of their adequacy can be made.
- Scour Critical Bridges – Identify the current status of the bridge regarding its vulnerability to scour.

4.1.5 The Role of Inventory Items in Bridge Management Systems

Inventory items are an important part of an owner's Bridge Management System (BMS). Bridge owners use the inventory items to help plan inspection, maintenance, and reconstruction of their bridges, as well as sort their bridges. There have been times when there has been a problem on a particular bridge and the owners used the inventory items of that bridge to search for the same potential problems that might exist on other bridges.

Table of Contents

Section 4
Bridge Inspection
Reporting System

This page intentionally left blank

Topic 4.2 Condition and Appraisal

4.2.1 Introduction

The reported condition of an element or component is an evaluation of its current physical state compared to what it was on the day it was built. The condition rating is not influenced by the ability of the element or component to carry legal loads. Appraisal rating items are used to evaluate a bridge in relation to the level of service it provides on the highway system of which it is a part. Condition rating is based on a comparison with the bridge's condition when it was built, whereas appraisal rating is based on a comparison with current service standards.

4.2.2 Condition Rating Items

Bridge Components and Elements

Accurate assignment of condition ratings is dependent upon the bridge inspector's ability to identify the bridge components and their elements. Bridge components are the major parts comprising a bridge including the deck, superstructure, substructure, channel and channel protection, and culverts. Bridge elements are individual members comprised of basic shapes and materials connected together to form bridge components.

The overall condition rating of bridge components is directly related to the physical deficiencies of bridge elements.

Evaluating Elements

The inspector should evaluate each element of a each component and assign to it a descriptive condition rating of "good," "fair," or "poor," based on the physical deficiencies found on the individual element. The following guidelines should be used in establishing an element's condition rating:

- Good - element is limited to only minor problems.
- Fair - structural capacity of element is not affected by minor deterioration, section loss, spalling, cracking, or other deficiency.
- Poor - structural capacity of element is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, or other deficiency.

To ensure a comprehensive inspection and as a part of the requirements of record keeping and documentation, an inspector should record the location, type, size, quantity, and severity of deterioration and deficiencies for each element of a given component.

Evaluating Components

The following Structure Inventory and Appraisal (SI&A) items receive an overall condition rating:

- Item No. 58 – Deck
- Item No. 59 – Superstructure
- Item No. 60 – Substructure
- Item No. 61 – Channel and Channel Protection
- Item No. 62 – Culverts

Items 58 through 60 are major components of bridges. Item 62 and the inspection of culverts is discussed in Topics 7.12, 12.3, and 12.4. Item 61 is used only for structures over waterways.

Condition Rating Guidelines

Numerical condition ratings should characterize the general condition of the entire component being rated. They should not attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition rating must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated. Condition ratings assigned to elements of a component must be combined to establish the overall component condition rating.

If the bridge has multiple spans, the inspector must evaluate all elements both quantitatively and qualitatively. However, in some cases, a deficiency will occur on a single element or in a single location. If that one deficiency reduces the load carrying capacity or serviceability of the component, the element can be considered a "weak link" in the structure, and the rating of the component must be reduced accordingly.

The following general condition rating guidelines (obtained from the 1995 edition of the *Coding Guide*) are to be used in the evaluation of the deck, superstructure, and substructure:

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION - no problems noted.
7	GOOD CONDITION - some minor problems.
6	SATISFACTORY CONDITION - structural elements show some minor deterioration.
5	FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	POOR CONDITION - advanced section loss, deterioration, spalling, or scour.
3	SERIOUS CONDITION - loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
1	"IMMINENT" FAILURE CONDITION - major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put bridge back in light service.
0	FAILED CONDITION - out of service; beyond corrective action.

The condition rating guidelines presented above are general in nature and can be applied to all bridge components and material types. Additional component specific condition rating guidelines are provided for Item 61, Channel and Channel Protection, and for Item 62, Culverts. (These component specific guidelines are shown below.) Rate and code the condition for Item 61 and Item 62 using the specific condition rating guidelines in accordance with the previously noted general condition rating guidelines.

Item 61 – Channel and Channel Protection

This item describes the physical conditions associated with the flow of water through the bridge such as stream stability and the condition of the channel, riprap, slope protection, or stream control devices, including spur dikes. The inspector should be particularly concerned with visible signs of excessive water velocity which may cause undermining of slope protection, erosion of banks, and realignment of the stream. Accumulation of drift and debris on the superstructure and substructure should be noted on the inspection form but not included in the condition rating.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use when bridge is not over a waterway (channel).
9	There are no noticeable or noteworthy deficiencies which affect the condition of the channel.
8	Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the channel slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.
3	Bank protection has failed. River control devices have been destroyed. Streambed aggradation, degradation, or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.
2	The channel has changed to the extent the bridge is near a state of collapse.

1 Bridge closed because of channel failure. Corrective action may put bridge back in light service.

0 Bridge closed because of channel failure. Replacement necessary.

Item 62 - Culverts

This item evaluates the alignment, settlement, joints, structural condition, scour, and other items associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint should be included in the evaluation.

Item 58 – Deck, Item 59 – Superstructure, and Item 60 – Substructure should be coded N for all culverts.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion, or moderate pitting.
5	Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.
4	Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.
3	Any condition described in Code 4 but which is excessive in scope.

Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls, or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.

2 Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

1 Bridge closed. Corrective action may put bridge back in light service.

0 Bridge closed. Replacement necessary.

A bridge's load-carrying capacity is not to influence condition ratings. The fact that a bridge was designed for less than current legal loads, and may even be posted, should have no influence upon condition ratings.

Structural capacity is defined as the designed strength of the member. However, structural capacity is different than load-carrying capacity. Load-carrying capacity refers to the ability of the member to carry the legal loads of the highway system of which the bridge is a part. Therefore, a bridge could possibly have good structural capacity yet be load posted because it is unable to carry the legal loads.

The load-carrying capacity of a bridge is reflected in the Structural Evaluation appraisal rating. A bridge's structural capacity is reflected in the condition ratings of the bridge components. Component ratings are determined by applying condition descriptions, which are general in nature, covering a broad array of bridge components and material types. The inspector must be familiar with terminology concerning material types and associated deterioration to utilize condition descriptions for accurately assigning condition ratings. The following illustrates several common deterioration terms found in condition descriptions and their associated material types:

- Section loss - usually applies to steel members or reinforcing steel
- Fatigue crack - applies to steel members
- Cracking/spalling - usually are used to describe concrete
- Shear crack - usually applies to concrete but may apply to timber as well
- Checks/splits - applies to timber members
- Scour - can apply to substructure or channels

Establishing a link between material type and deterioration allows for accurate component ratings determined by utilizing condition descriptions for ratings 9 through 1 found in the general condition rating guidelines.

Supplemental rating guidelines, which may be developed by individual states, are intended to be used in addition to the *Coding Guide* to make it easier for the inspector to assign the most appropriate condition rating to the component being considered and improve uniformity.

Using the material and component specific supplemental rating guidelines (found in the 1995 edition of the *Coding Guide*) helps to clarify how each type of defect affects the condition rating. Care must be taken not to "pigeonhole" the rating based on only one word or phrase. The following is one suggested method for determining proper condition ratings:

- Identify phrases that describe the component
- Read through the rating scale until encountering phrases that describe conditions that are more severe than what actually exists
- Be sure to read down the ratings list far enough
- Correct rating number then is one number higher

This procedure should generally work with all of the condition rating guidelines.

Condition State Assessment

A narrative description with quantities is required in the first part of the inspection. Condition state summaries are then developed for the bridge element. The information from the narrative and condition state summaries are then used to complete the element level condition report showing quantities at the correct rating value. Smart Flags are also used to specifically describe deck cracking (top and underside), fatigue cracking, pack rust, settlement, and scour. Refer to Topic 4.6 for a more detailed explanation of the Element Level Bridge Management System.

4.2.3 Appraisal Rating Items

Appraisal Rating Guidelines

The following SI&A items are known as appraisal rating items:

- Item No. 67 – Structural Evaluation
- Item No. 68 – Deck Geometry
- Item No. 69 – Underclearances, Vertical and Horizontal
- Item No. 71 – Waterway Adequacy
- Item No. 72 – Approach Roadway Alignment

Appraisal rating items are used to evaluate a bridge in relation to the level of service it provides on the highway system of which it is a part. The level of service for a bridge describes the function the bridge provides for the highway system carried by the bridge. The structure should be compared to a new one that is built to current standards for that particular class of road. The exception is Item 72, Approach Roadway Alignment. Rather than comparing the alignment to current standards, it is compared to the general existing alignment of the section of roadway that the highway is on.

The level of service goals used to appraise bridge adequacy vary depending on the highway functional classification, traffic volume, and other factors. The goals are set with the recognition that widely varying traffic needs exist throughout highway systems. Many bridges on local roads can adequately serve traffic needs with lower load capacity and geometric standards than would be necessary for bridges on heavily traveled main highways.

If national uniformity and consistency are to be achieved, similar structure, roadway, and vehicle characteristics must be evaluated using identical standards. Therefore, tables and charts have been developed which must be used to evaluate the appraisal rating items for all bridges submitted to the National Bridge Inventory, regardless of individual State criteria used to evaluate bridges.

The following general appraisal rating guidelines (obtained from the 1995 edition of the *Coding Guide*) are used to evaluate structural evaluation, deck geometry, underclearances, waterway adequacy, and approach roadway alignment.

Code	Description
N	Not applicable
9	Superior to present desirable criteria
8	Equal to present desirable criteria
7	Better than present minimum criteria
6	Equal to present minimum criteria
5	Somewhat better than minimum adequacy to tolerate being left in place as is
4	Meets minimum tolerable limits to be left in place as is
3	Basically intolerable, requiring high priority of corrective action
2	Basically intolerable, requiring high priority of replacement
1	This value of rating code not used
0	Bridge closed

The specific tables for Items 67 through 69, 71 and 72 appear in the *Coding Guide* and are detailed enough that several states now program their computerized bridge management system to automatically calculate several of the appraisal rating items. Thus, some inspectors may not be responsible for coding these items. Inspectors may be asked to field verify the computed appraisal ratings.

Item 67 - Structural Evaluation - The item description and procedures used to determine the Structural Evaluation Appraisal Rating are located in Item 67 of the *Coding Guide*. The correct way to evaluate this item for bridges is to consider the following factors:

- The lowest rating dictated by Item 59 - Superstructure, Item 60 - Substructure or Comparison of Item 29 - ADT and Item 66 - Inventory Rating.
- For culverts, the lower of Item 62 - Culverts or Comparison of Item 29 - ADT and Item 66 - Inventory Rating.

Item 68 - Deck Geometry - The deck geometry appraisal evaluates the curb to curb bridge roadway width and the minimum vertical clearance over the bridge roadway. This item is coded by determining two appraisal ratings, one for bridge roadway width and one for the minimum vertical clearance. The lower of these two is the appraisal rating. The *Coding Guide* includes the following scenarios to choose from for the bridge roadway width appraisal:

- Bridges with two lanes carrying two-way traffic.
- Bridges with one lane carrying two-way traffic.

- All other two-way traffic situations.
- Bridges with one-way traffic.

Item 69 - Underclearances, Vertical and Horizontal - This item refers to the vertical and horizontal underclearances from the through roadway under the structure to the superstructure or substructure units. The item description and coding guidelines, which are located in Item 69 of the *Coding Guide*, are used to determine the Underclearance Appraisal Rating. This item is similar to Item 68 in that two different ratings are developed: one for vertical underclearance and one for horizontal underclearance. The lower of these two is the appraisal rating.

Item 71 - Waterway Adequacy - Waterway adequacy is appraised with respect to passage of flow through the bridge. The rating is tied to flood frequencies and traffic delays. Appraisal ratings are assigned by the table contained in Item 71 of the *Coding Guide* and are based on the functional classification of the road carried by the structure, hydraulic and traffic data for the structure, and site conditions.

Item 72 - Approach Roadway Alignment – This appraisal is based on comparing the alignment of the bridge approaches to the general highway alignment of the section of roadway on which the structure is located. The rating guidelines are correctly applied by determining if the vertical or horizontal curvature of the bridge approaches differs from the section of highway the bridge is on, resulting in a reduction of vehicle operating speed to cross the bridge. The guidelines for FHWA Item 72, Appraisal or Approach Roadway Alignment, are as follows:

- If no reduction in the operating speed of a vehicle is required compared to the highway, code Item 72 as an “8.”
- If only a very minor reduction in the operating speed of a vehicle is required compared to the highway, code Item 72 as a “6.”
- If a substantial reduction in the operating speed of a vehicle is required compared to the highway, code Item 72 as a “3.”

The following guidelines indicate a means of determining the difference between a minor reduction and substantial reduction of operating speed:

- Minor reduction in operating speed - $\leq$ 9 mph
- Substantial reduction in operating speed - $\geq$ 10 mph

The remaining codes between these general values should be applied at the inspector’s discretion.

A narrow bridge does not affect the Approach Roadway Alignment Appraisal. The narrow bridge would be accounted for in Item 68, Deck Geometry.

Items affecting sight distance at the bridge, unrelated to vertical and horizontal curvature of the roadway, such as vegetation growth and substructure units of overpass structures do not affect the Approach Roadway Alignment Appraisal.

Item 36 - Traffic Safety Features - For structures on the National Highway System (NHS), this appraisal is based on comparing the traffic safety features in place at the bridge site to current national standards set by regulation, so that an evaluation of their adequacy can be made. For structures not on the National Highway

System (NHS), the procedure is the same, however, it shall be the responsibility of the highway agency (state, county, local, or federal) to set standards. The item description and procedures used to determine the Traffic Safety Feature Appraisal Rating are located in Item 36 of the *Coding Guide*. The following are the traffic safety features to be coded:

- Bridge Railings
- Transitions
- Approach Guiderail
- Approach Guiderail Ends

Item 113 - Scour Critical Bridges – This item is used to identify the current status of the bridge regarding its vulnerability to scour. A scour critical bridge is one with abutment or pier foundations that are rated as unstable due to observed scour at the bridge site, or a scour potential as determined form a scour evaluation study including a scour analysis made by hydraulic, geotechnical, or structural engineers. The item description, procedures, and code descriptions are located in Item 113 of the *Coding Guide.*

4.2.4 Maintenance Rating Guidelines

It is usually necessary to evaluate the condition of more items than those rated on the SI&A forms, because the SI&A condition items cover such broad components. For example, SI&A Item 62 covers all structural components of a culvert. Additionally, the SI&A numerical rating system is not well suited for evaluating minor items. Minor items are essentially limited to ratings of “N”, “9”, “8”, or “7” since the other rating numbers imply a significant impact on the overall integrity or safety of the structure. Therefore, a modified rating system should be used for rating the condition of items added to supplement the SI&A items. Since items are added primarily to identify potential maintenance problems, the modified rating scale should be oriented toward maintenance.

A sample maintenance rating system is shown in Table 4.2.1. The rating system shown provides a numerical scale that is related to the urgency of maintenance action required, as well as the action which should be taken by the inspector.

It is important to note that the inspector basically has three courses of action, depending on the severity of conditions found. Each of these actions involves noting the condition of the components in the inspection report. When no immediate maintenance actions are required, the note in the report is all that is necessary. When a high priority should be assigned for correcting problems found during the inspection, some type of special notification to maintenance personnel is recommended. When immediate action is required to address a hazardous situation or preserve the integrity of the structure, maintenance personnel should be notified on an emergency basis.

Care must be exercised when using different rating systems, particularly when combining the ratings given to supplemental items to arrive at ratings for SI&A items. SI&A item ratings usually represent a composite rating of a group or broad category of supplemental items. The SI&A ratings should not merely be an average of the ratings assigned to the supplemental items but should be based on the inspector’s judgement. A low rating in one supplemental item will usually control the composite rating.

Maintenance Urgency Index	Maintenance Immediacy of Action	Inspection Course of Action
9	No repairs needed.	Note in inspection report only.
8	No repairs needed. List specific items for special inspection during next regular inspection.	
7	No immediate plans for repair. Examine possibility of increased level of inspection.	
6	Repair by end of next season – add to scheduled work.	
5	Place in current schedule – current season, first reasonable opportunity.	Special notification to superior is warranted.
4	Priority – current season, review work plan for relative priority, adjust schedule if possible.	
3	High priority – current season, as soon as can be scheduled.	
2	Highest priority – discontinue other work if required, emergency basis or emergency subsidiary actions if needed (post, one-lane traffic, no trucks, reduced speed, etc.).	Verbally notify superiors immediately and confirm in writing.
1	Emergency actions required – reroute traffic and close.	
0	Facility is closed for repairs.	

Table 4.2.1 Maintenance Rating Scale

4.2.5 Overall Culvert Ratings

General

Topics 7.12, 12.3, and 12.4 address the individual components of various culverts. Overall ratings consider all of the components which make up a culvert and are useful in establishing maintenance, rehabilitation, and replacement programs and priorities.

Some of a culvert's individual components are not rated in the SI&A sheet. However, they are useful supplemental items in defining the condition and in determining the overall ratings. The SI&A sheet has several items that require evaluation of the culvert as a whole. The SI&A items can be divided into three categories: overall condition, load-carrying capacity, and remaining life.

Overall Condition

Two items on the SI&A sheet pertain to the overall condition of culverts. Item 62, Culverts, covers the condition of the culvert's structural and hydraulic components (alignment, settlement, culvert barrel, end treatment, and embankment). Item 67, Structural Evaluation, covers the evaluation of the structural components and the load-carrying capacity.

Overall ratings must not be an average of the ratings assigned to individual components. Very often a low rating for one component will control the overall rating, but when assigning an overall rating, the inspector should consider each component and its possible effect on the culvert. The inspector should consider whether the component is functioning properly, whether it could pose a threat to safety or cause property damage, whether it could cause more extensive damage if not repaired, and whether the repairs represent rehabilitation or maintenance.

Load-carrying Capacity

SI&A Items 64, 66, and 70 are based on the loads which the structure can carry. Item 64, Operating Rating, is the maximum load the structure can carry. Item 66, Inventory Rating, is the load which can be carried repeatedly for an indefinite period of time. Item 70, Bridge Posting, is a rating based on an evaluation of the culvert's load-carrying capacity and the state's legal load limits. The procedures used for determination of these capacity ratings should take into account the condition of the culvert at the time of the inspection.

Remaining Life

The inspector estimates the number of years that remain before major rehabilitation or replacement of the culvert is required. The estimate should be based on the design life of the barrel material, the years of service prior to the inspection, and the condition of the culvert at the time of the inspection. The current condition and the performance of the culvert material under similar conditions are the key considerations. Where durability is a problem, electrical resistivity and pH measurements of the surrounding soil and the stream may be helpful in estimating the remaining life.

4.2.6 Sufficiency Rating

Definition

Sufficiency rating (S.R.) is a calculated numeric value used to indicate the sufficiency of a bridge to remain in service. The rating is calculated using the sufficiency rating formula. Sufficiency rating is discussed in detail in Appendix B of the *Coding Guide*.

Sufficiency Rating Formula

$$S.R. = S_1 + S_2 + S_3 - S_4$$

0% (entirely deficient)	≤	S.R.	≤	100% (entirely sufficient)

where: S_1 = 55% max.; based on structural adequacy and safety (i.e., superstructure or substructure condition and load capacity).

S_2 = 30% max.; deals with serviceability and functional obsolescence (items such as deck condition, clearances, roadway alignment and width, etc.).

S_3 = 15% max.; concerns essentiality for public use (items such as detour length, average daily traffic, and defense highway designation).

S_4 = 13% max.; deals with special reductions based on detour length, traffic safety features, and structure type.

Eighteen SI&A sheet items are used to calculate these four factors which therefore determine the sufficiency rating. Sufficiency rating is not normally calculated manually. Usually, it is included in the agency's inventory computer program and is calculated automatically by the computer based upon the inventory data collected by the bridge inspector.

Uses

Sufficiency Rating (SR) is used by the federal and state agencies to determine the relative sufficiencies of all of the nation's bridges. In the recent past, eligibility for federal funding with Highway Bridge Replacement and Rehabilitation Program funds has been determined by the following criteria:

$S.R. \leq 80$	Eligible for rehabilitation
$S.R. < 50$	Eligible for replacement

Some states use the sufficiency rating as the basis for establishing priority for repair or replacement of bridges; the lower the rating, the higher the priority. Several states are developing specific bridge management procedures with priority guidelines for repair or replacement of bridges. By using these types of procedures, priority ratings can be established by considering the significance or impact of such level-of-service parameters as traffic volume and class of highway.

Table of Contents

Section 4
Bridge Inspection
Reporting System

Abbreviations for Field Inspection Notes

Abut. = Abutment
Adj. = Adjacent
B. = Bent
Betw. = Between
Bot. = Bottom
B.S. = Both Sides
[= Channel (Steel Shape)
cm = Centimeter
Col. = Column
Conc. = Concrete
Cond. = Condition
Conn. = Connection
Cr. = Crack
Delam. = Delamination, Delaminated
Deter. = Deterioration
Diag. = Diagonal
Diam. = Diameter
Diaph. = Diaphragm
D.S. = Downstream
E = East
Eff. = Efflorescence
Elev. = Elevation
Expan. = Expansion
F.B. = Floorbeam
F.L. = Full Length
Flg. = Flange
F.S. = Far Side
Ft. = Feet
Gus. = Gusset
H.L. = Hairline
Horz. = Horizontal
Hvy. = Heavy
Int. = Interior
Lac. = Lacing
Lat. = Lateral
Lat. Br. = Lateral Brace
Len. = Length
Low. = Lower
Lt. = Light
M = Meters
Med. = Medium
Mid. = Middle
N = North
No Vis. Def. = No Visible Defects
N.S. = Near Side
P = Pier
Pl. = Plate
S = South
S.I.P. = Stay-in-Place Forms
SF = Square Feet
Stiff. = Stiffener
Str. = Stringer
T. Welds = Tack Welds
Typ. = Typical
U = Upper
U.S. = Upstream
Vert. = Vertical
Vis. = Visible
Vis. S. = Visible Signs
W = West
W = Wide Flange (Steel Shape)
L = Angle (Steel Shape)

Topic 4.3 Record Keeping and Documentation

4.3.1 Introduction

While the inspection of small bridges usually only requires the use of the standard inspection form, the inspection of large or complex bridges requires the use of an inspection notebook, in addition to any standard inspection forms. The inspection notebook should contain:

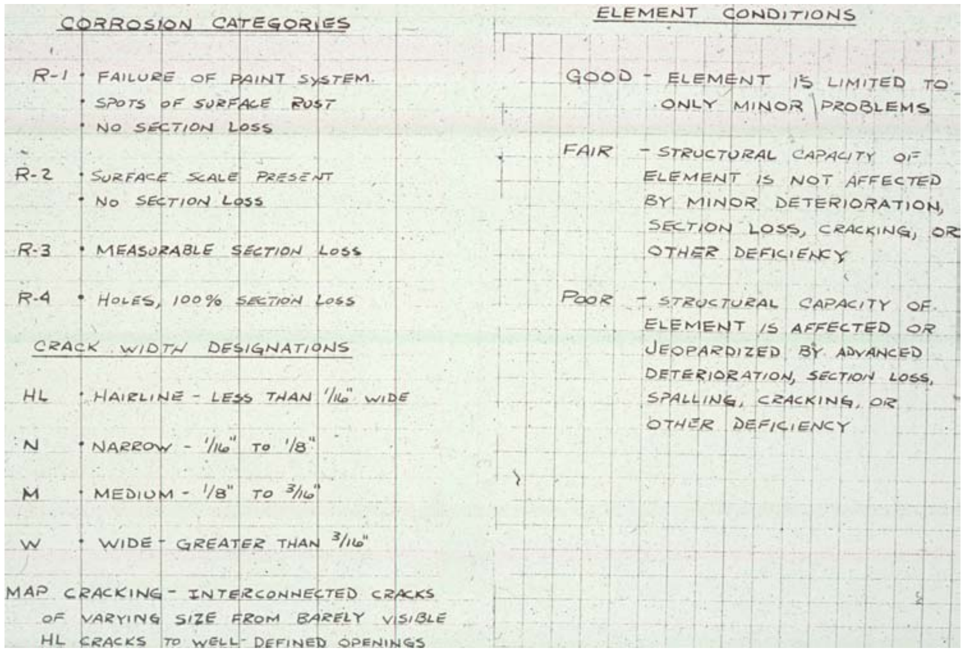
- A standard notation system for indicating the condition of the elements or members
- Sketches of elements or members showing typical and deteriorated conditions (some of these can be pre-made to allow more expediency during the inspection)
- Standard nomenclature and abbreviations for the elements of members and the components made up of these members
- A log or index for photographs
- Brief narrative descriptions of general and component conditions

When the notebook format is selected for recording bridge inspection results, the information should be recorded systematically. However, many state agencies differ significantly in their required format. Most of the above information, if not provided on the inspection report, should be available in the structure file.

4.3.2 Methods of Record Keeping

Traditional

All signs of distress and deterioration should be noted with sufficient precision so that future inspectors can readily make a comparison of conditions. The most commonly used method for record keeping is pencil and paper. The inspector writes findings on forms, sketches, and notebooks (see Figure 4.3.1). This method is extremely flexible in that the inspector can draw whatever configurations are necessary to best describe and document deficiencies. During an inspection, trying to climb and write at the same time is obviously not a safe practice. Therefore, it is a good idea to secure a safe position before attempting to record any findings.


CORROSION CATEGORIES

R-1 • FAILURE OF PAINT SYSTEM.
• SPOTS OF SURFACE RUST
• NO SECTION LOSS

R-2 • SURFACE SCALE PRESENT
• NO SECTION LOSS

R-3 • MEASURABLE SECTION LOSS

R-4 • HOLES, 100% SECTION LOSS

CRACK WIDTH DESIGNATIONS

HL • HAIRLINE - LESS THAN 1/16" WIDE

N • NARROW - 1/16" TO 1/8"

M • MEDIUM - 1/8" TO 3/16"

W • WIDE - GREATER THAN 3/16"

MAP CRACKING - INTERCONNECTED CRACKS OF VARYING SIZE FROM BARELY VISIBLE HL CRACKS TO WELL-DEFINED OPENINGS

ELEMENT CONDITIONS

GOOD - ELEMENT IS LIMITED TO ONLY MINOR PROBLEMS

FAIR - STRUCTURAL CAPACITY OF ELEMENT IS NOT AFFECTED BY MINOR DETERIORATION, SECTION LOSS, CRACKING, OR OTHER DEFICIENCY

POOR - STRUCTURAL CAPACITY OF ELEMENT IS AFFECTED OR JEOPARDIZED BY ADVANCED DETERIORATION, SECTION LOSS, SPALLING, CRACKING, OR OTHER DEFICIENCY

Figure 4.3.1 Sample Notation

Electronic Data Collection

A new method of record keeping is electronic data collection (see Figure 4.3.2). This new technology provides a significant advantage in a number of areas. With all the bridge data available at the site, the inspector can retrieve and edit previous records. This not only saves time but eliminates the need for reentering data. Also, it eliminates errors that can occur when transferring the inspector's field notes to the computer back at the office. Electronic data collection provides a logical and systematic sequence of inspection, ensuring that no bridge elements are overlooked. It also allows the inspector to compare the current deficiencies with previous reports and note if the situation has gotten worse.

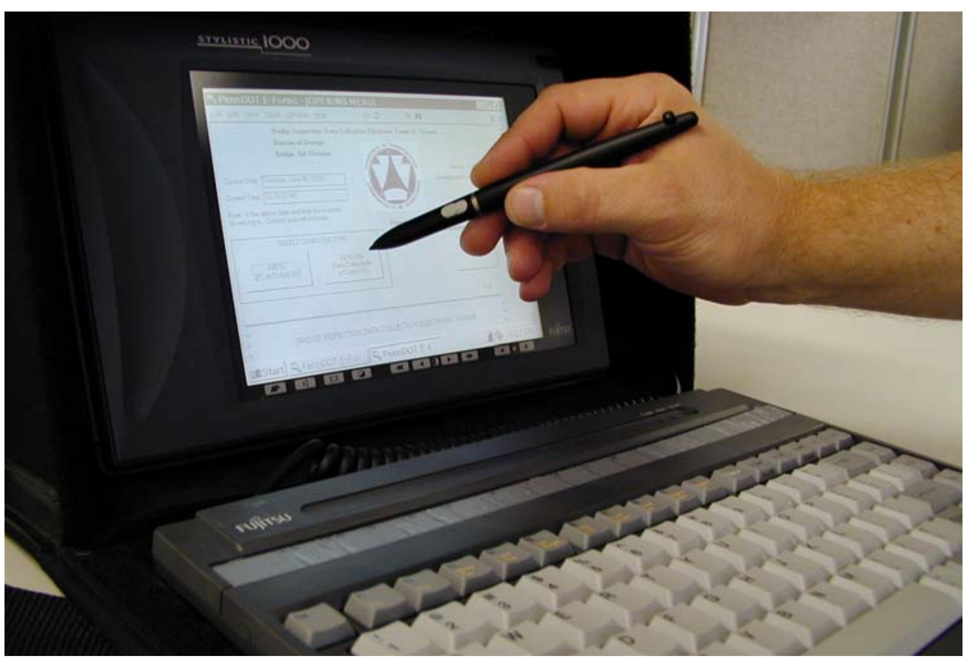


Figure 4.3.2 Electronic Data Collection

4.3.3

Typical Record Setup

A typical field notebook should contain the following:

- Title page
- Table of contents
- Inspection notes and sketches
- Photo log
- Summary of findings
- Inspection forms

Title Page

The front of a title page should contain:

- Name of structure
- Structure Identification Number
- Location
- Features intersected
- District
- County

The back of the title page should contain:

- Date
- Names of inspectors (indicating the team leader)
- Field book number
- Temperature
- Weather conditions

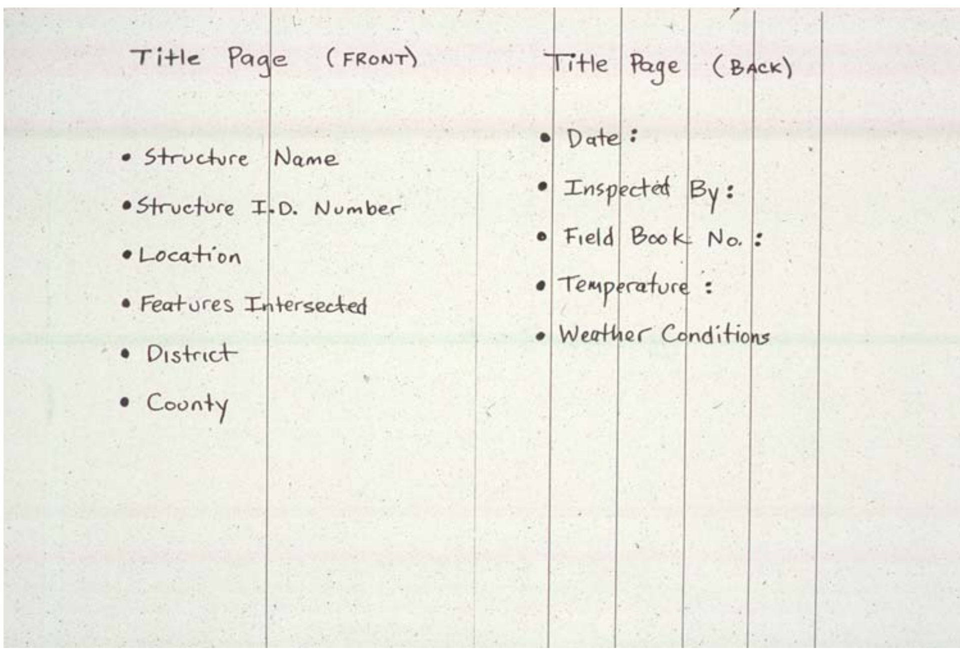


Figure 4.3.3 Sample Notebook Title Page

Table of Contents

The table of contents should be used to provide an outline of the notebook for quick reference. Figure 4.3.4 illustrates an example of a table of contents setup.

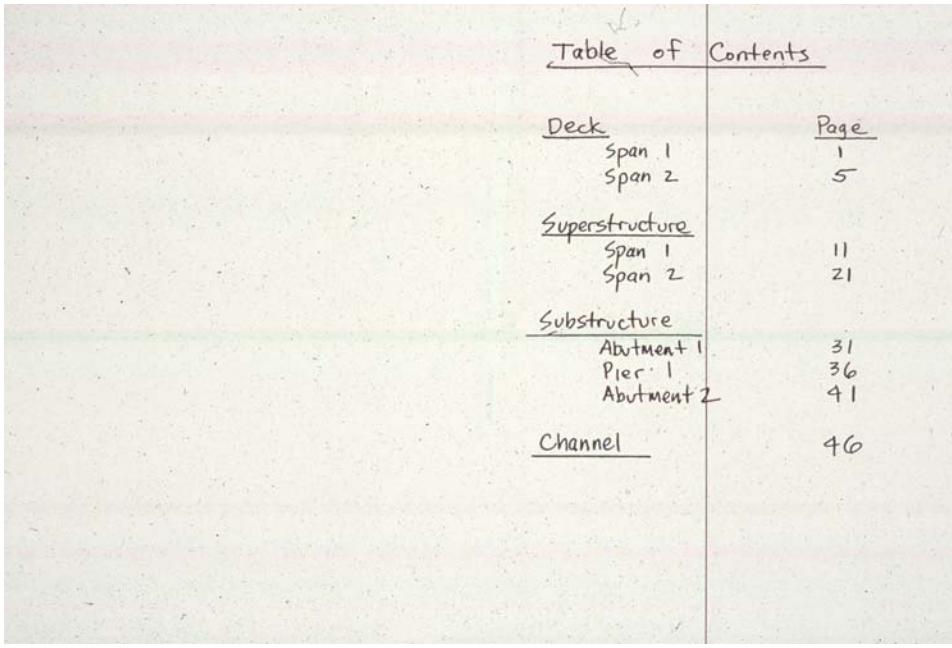


Figure 4.3.4 Sample Notebook Table of Contents

Inspection Notes and Sketches

The left-hand page should contain the element identification, descriptive rating (i.e., good, fair, poor), and comments. The right-hand page should be reserved for sketches or drawings of the elements (see Figure 4.3.5).

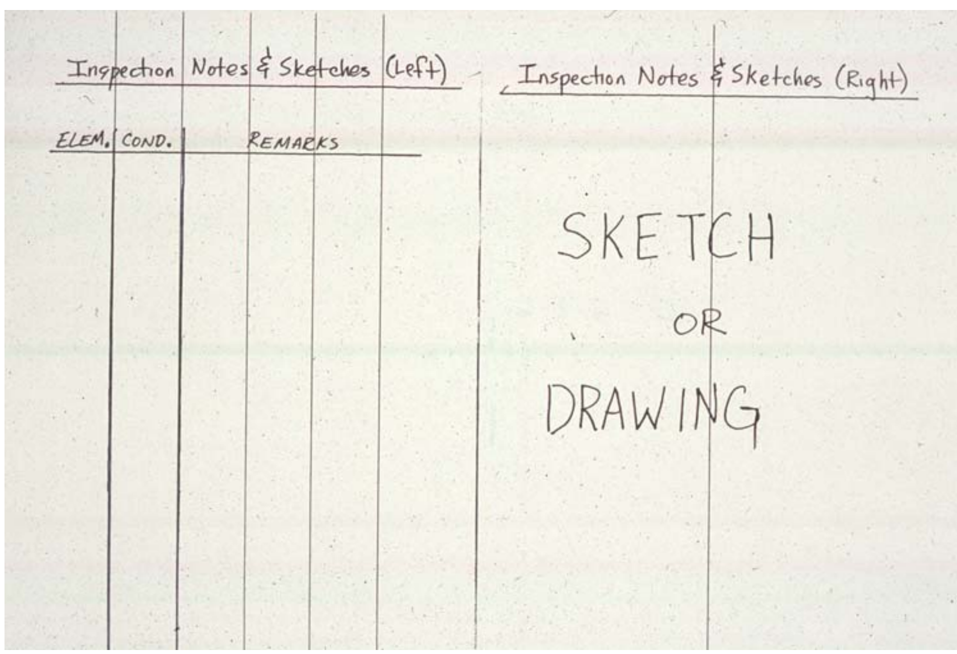


Figure 4.3.5 Sample Notes and Sketches Page

In most cases, it will be possible to insert reproductions of portions of the plans in the notebook. However, in some instances, sketches will have to be drawn. The inspector may be able to pre-draw the sketches in the office and fill them out in the field (see Figures 4.3.6 through 4.3.8).

S.O. No. ______________________

Subject: ______________________

______________________ Sheet No. ______ of ______

______________________ Drawing No. ______________

Computed by __________ Checked By __________ Date ______________

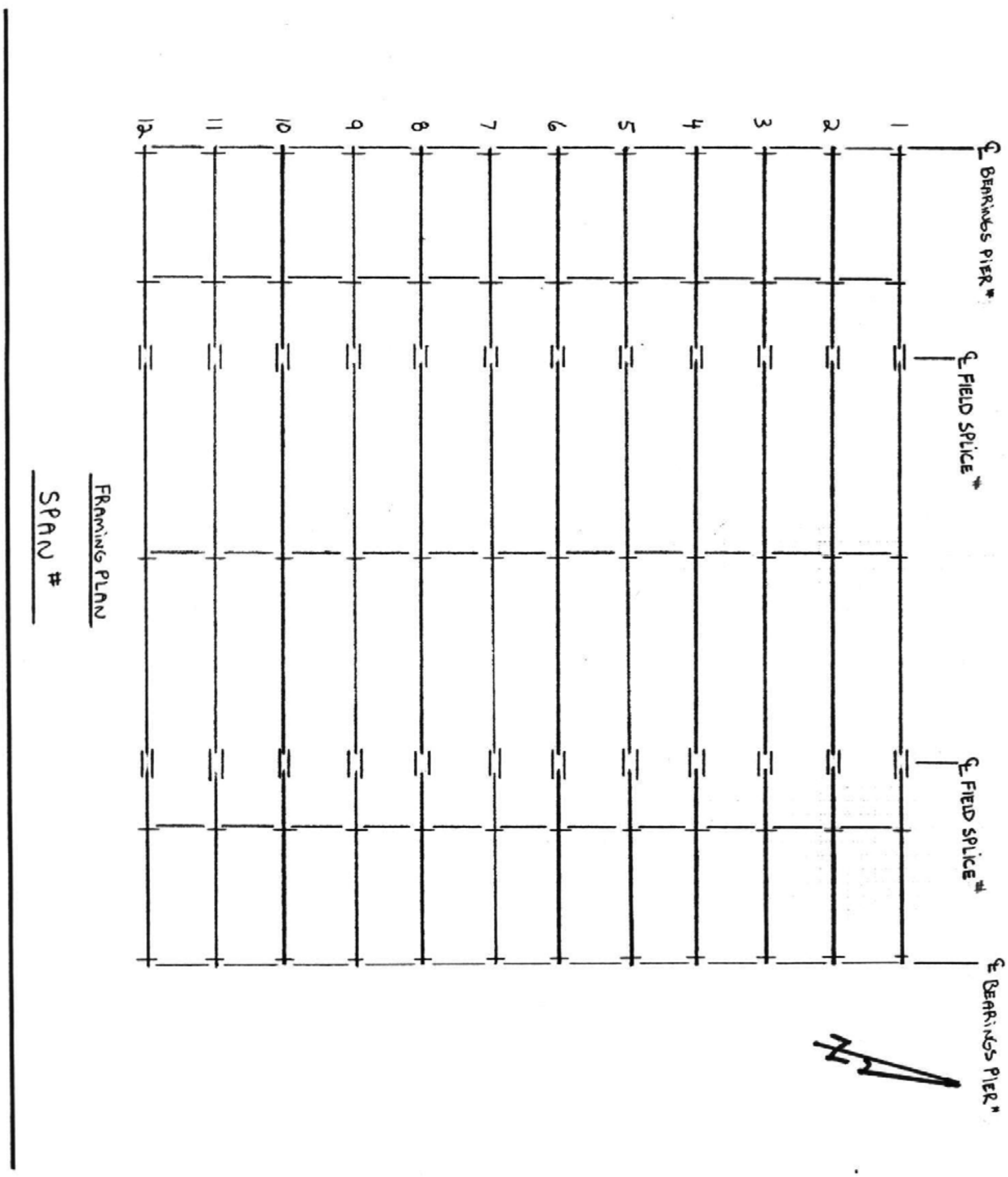


Figure 4.3.6 Framing Plan

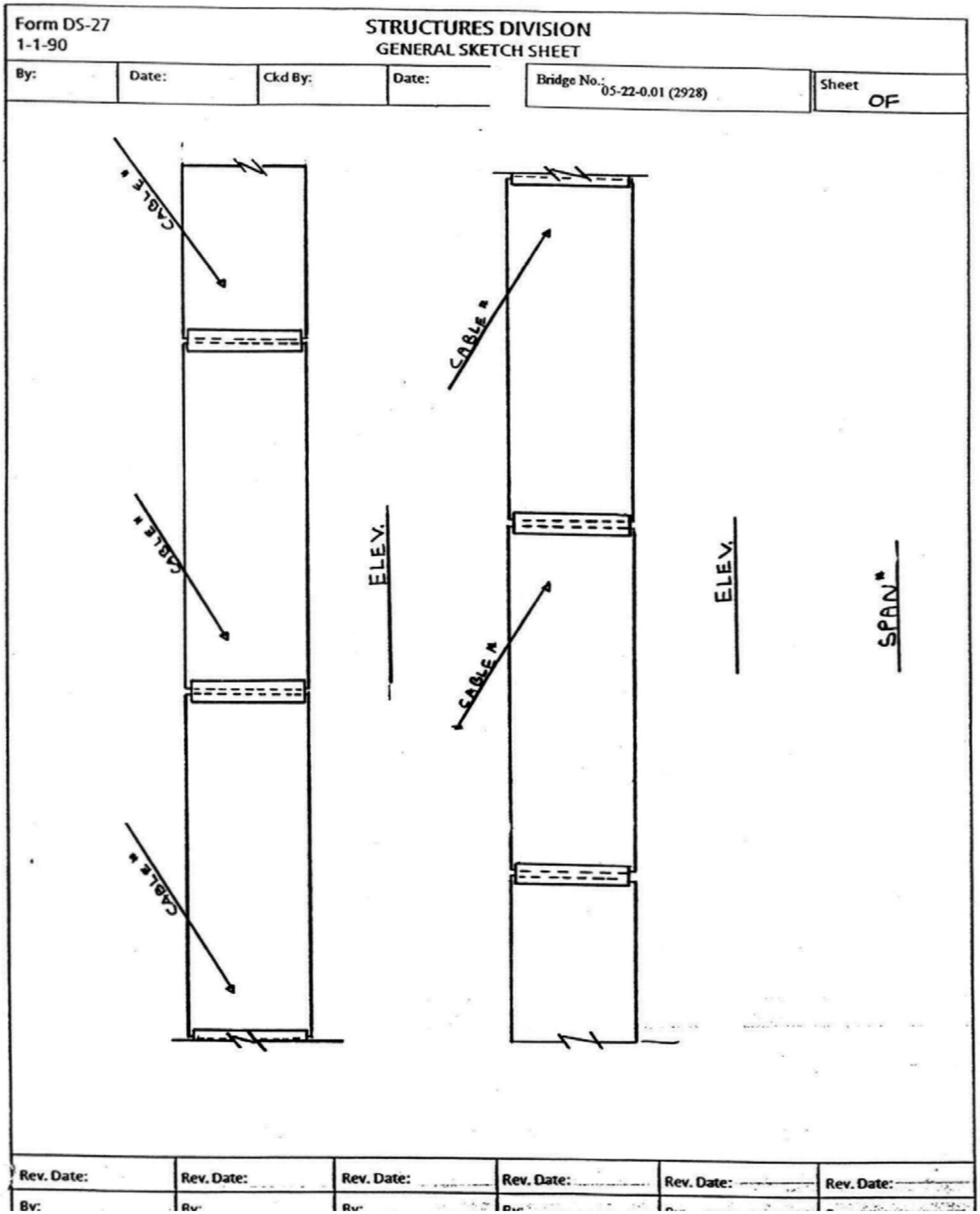


Figure 4.3.7 Girder Elevation

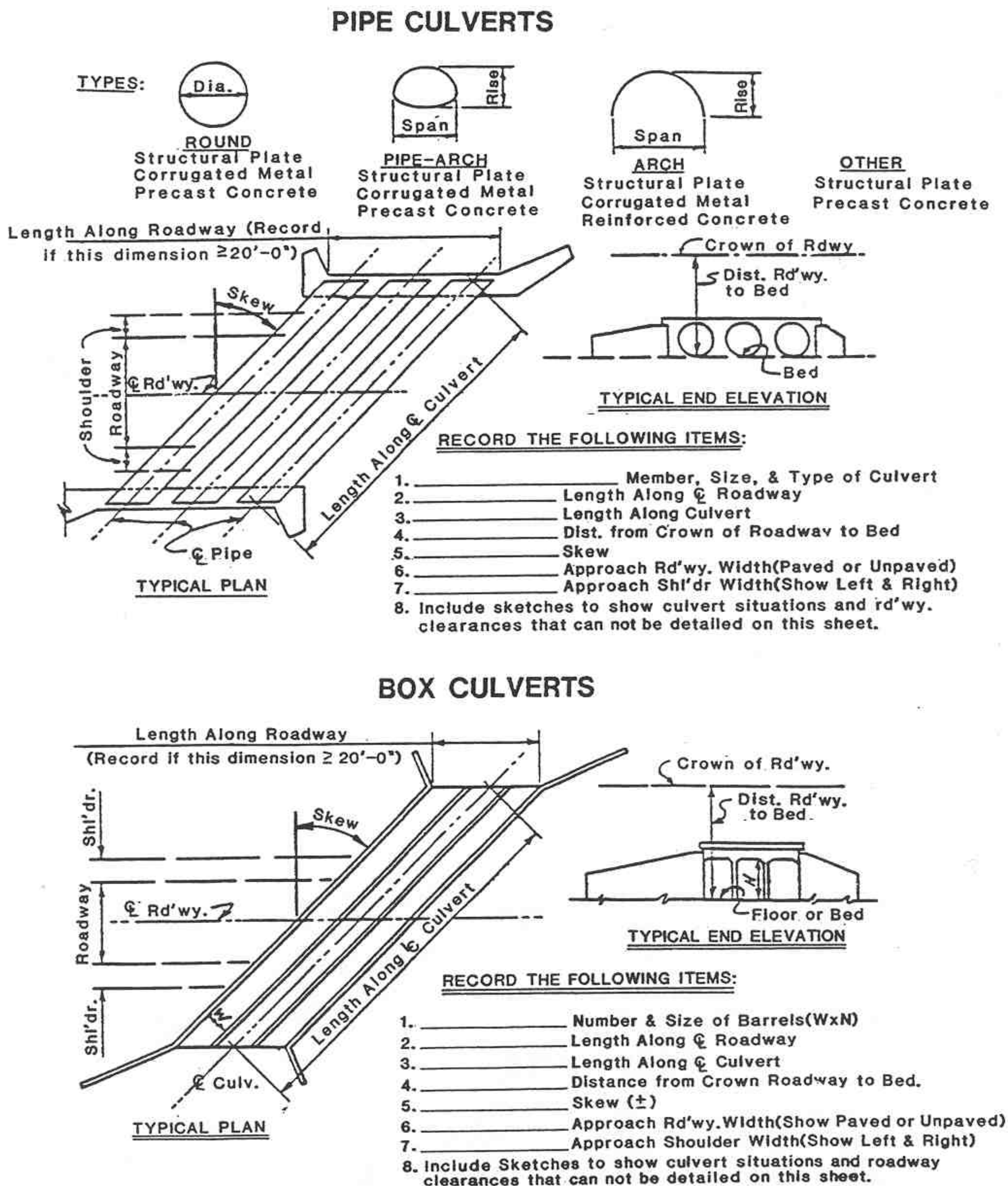


Figure 4.3.8 Typical Prepared Culvert Sketches

The first sketch in the field notebook should schematically portray the general layout of the bridge and site information, illustrating the structure plan and elevation data (see Figures 4.3.9 and 4.3.10). The immediate area, the stream or terrain obstacle layout, major utilities, and any other pertinent details should be included.

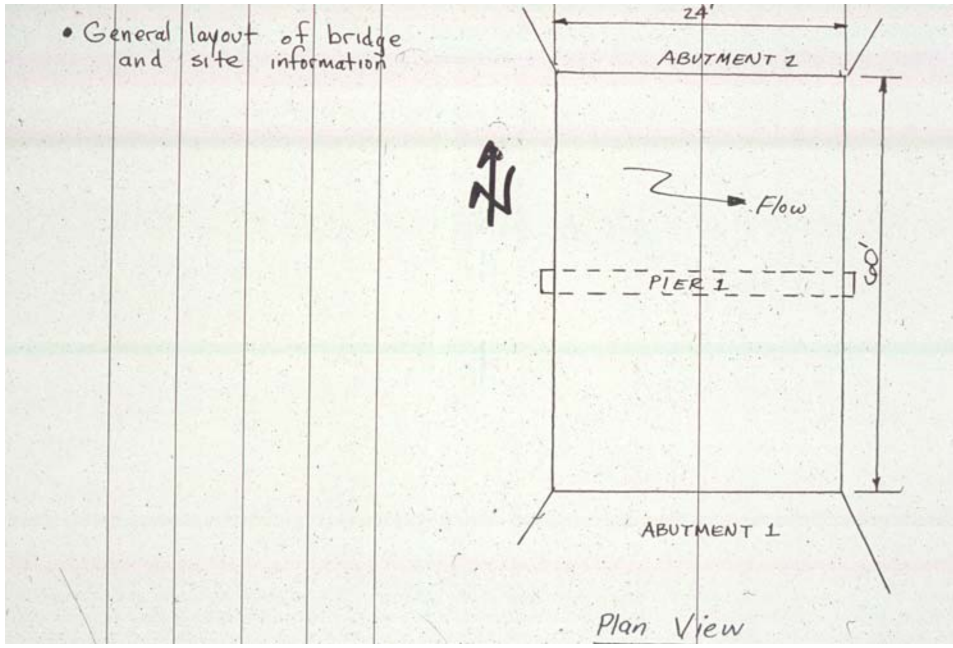


Figure 4.3.9 Sample General Plan Sketch

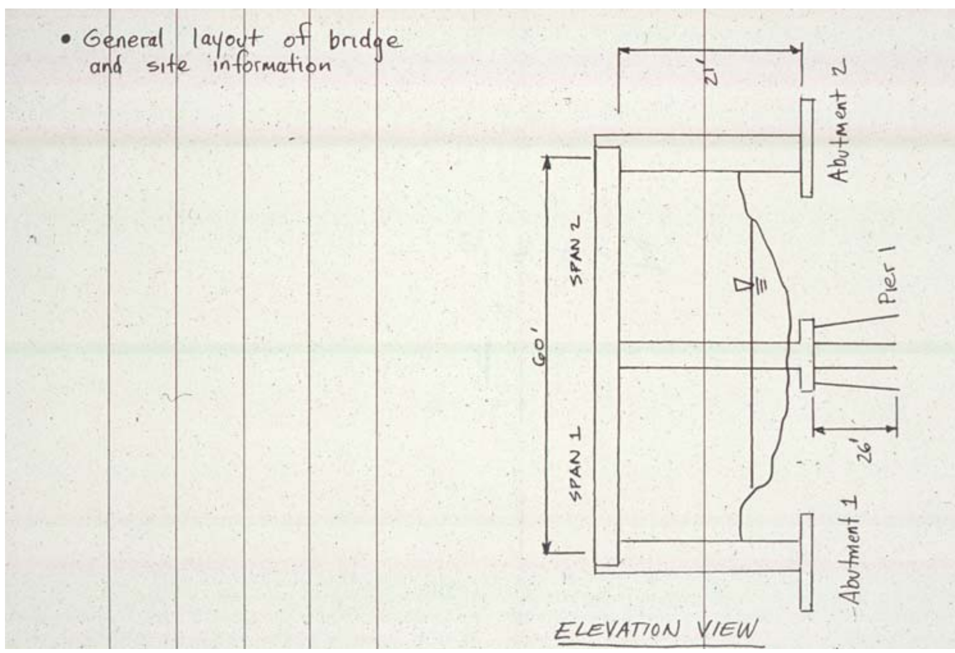


Figure 4.3.10 Sample General Elevation Sketch

Deck sketches should include expansion joints, construction joints, curbs, sidewalks, parapets, and railings (see Figure 4.3.11).

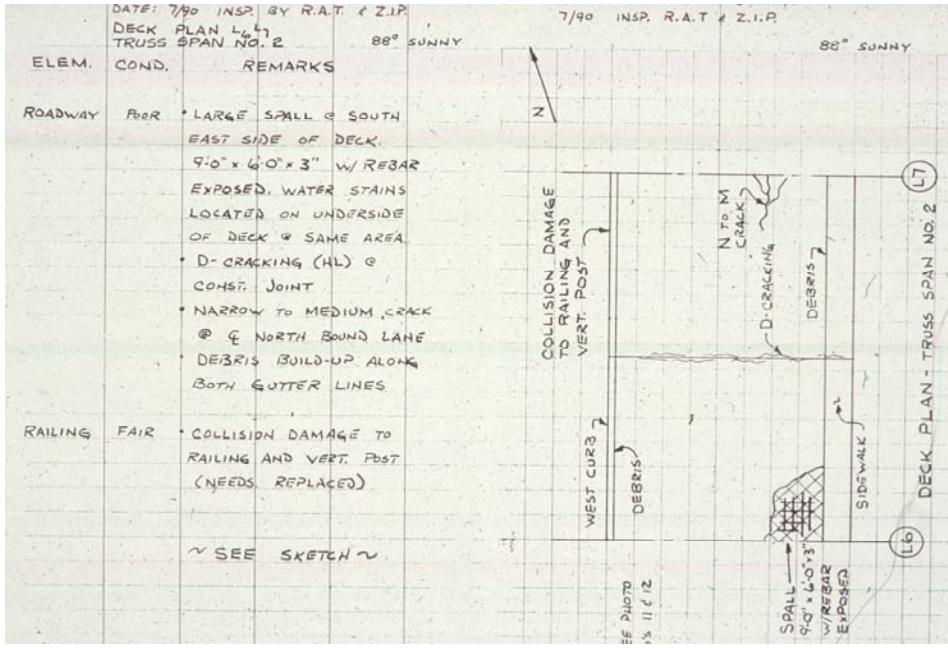


Figure 4.3.11 Sample Deck Inspection Notes

Superstructure units should be sketched both in cross section, plan, and elevation views. Items to be numbered include bearings, main supporting members, floorbeams, stringers, bracing, and diaphragms (see Figure 4.3.12).

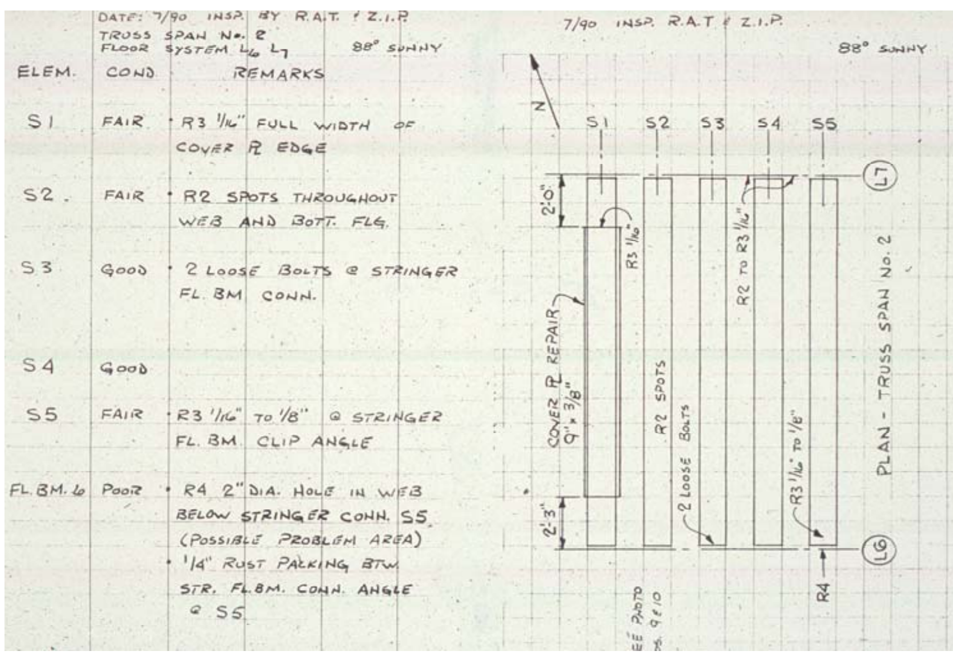


Figure 4.3.12 Sample Superstructure Inspection Notes

Sketches or drawings of each substructure unit should be included (see Figure 4.3.13). In many cases, it is sufficient to draw typical units that identify the principal elements of the substructure. Each of the elements of a substructure unit should be numbered so that they can be cross referenced to the information appearing on the data page on the left-hand side of the sketch. Items to be numbered include piling, footings, vertical supports, lateral bracing of members, and caps.

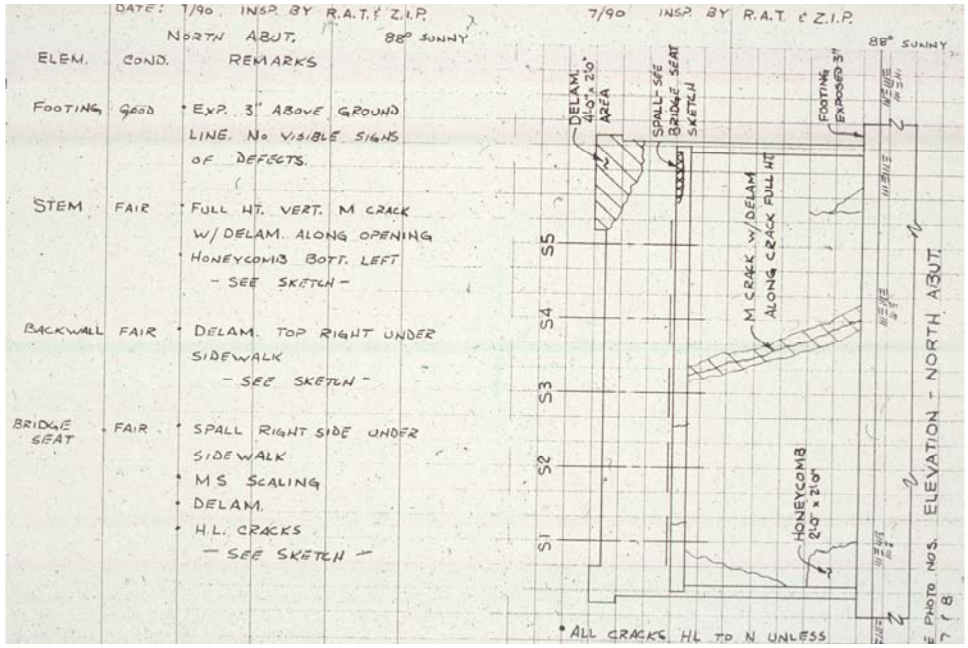


Figure 4.3.13 Sample Substructure Inspection Notes

Photo Log

A photo log should also be kept during the inspection. The photo log should include the date, roll or disk number, photo number, and description of each photograph. It is best to be very specific when describing the photos (see Figure 4.3.14). Descriptions should include both the location of the member and a brief description of any deficiencies.

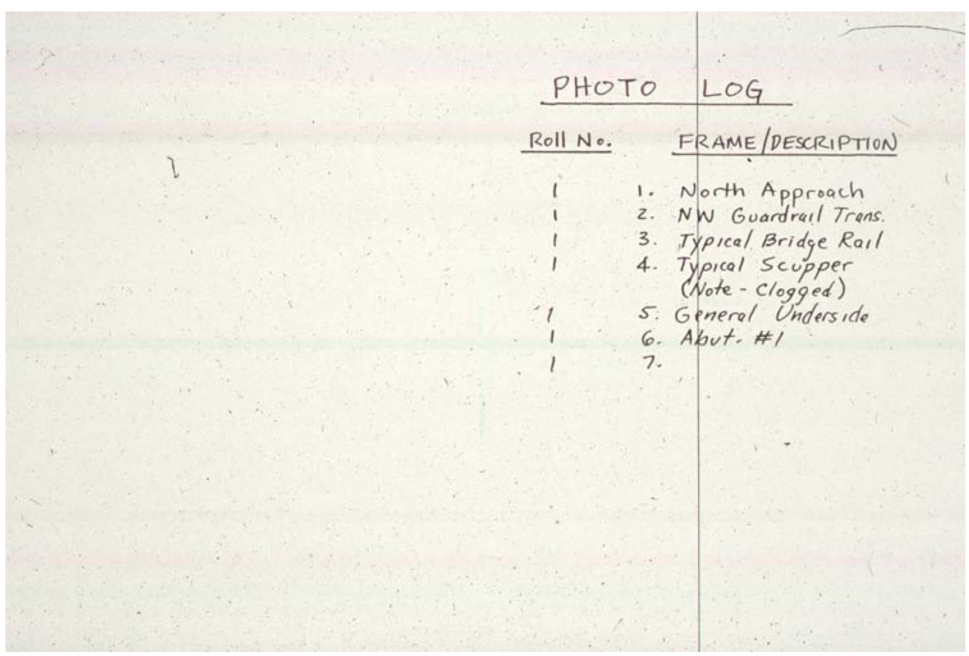


Figure 4.3.14 Sample Photo Log

Summary of Findings

The most important section of any field notebook is the inspector's findings. All deficiencies should be reported, no matter how minor they may seem. The inspector should be as descriptive as necessary to report not only the severity of the defect but the location as well. This will be described in further detail later in this section.

Inspection Forms

Many state agencies have standard inspection forms. These forms are used for each bridge in their system and give the inspector a checklist of items that are to be reviewed. Another benefit is that it organizes all bridge reports into one standard format (see Figures 4.3.15 and 4.3.16).

PDT Form D-450A (DEC 1996) **Site Data**

BRIDGE MANAGEMENT SYSTEM
BRIDGE INSPECTION REPORT

BMS Updated b ______ Date ______

A01 ___ Over ___

C05 Structure Type (Dept.) Main ___ Approach ___

Inspection Date E06 ___ Name of Consultant and/or Inspectors E12 ___

Inspection Type E07 ___ Inspected by E08 ___ Hired by E13 ___ Time started ___ Weather Conditions: Temp: ___

Time completed ___

☐ City ☐ Borough ☐ Township

Optional Reminder: Check boxes if Maintenance Activities are needed --> x

Bridge Signing Verification

BMS Item	Type of Sign	Required Sign	SIGNING IN FIELD: Near Advance	Bridge Site: Near	Bridge Site: Far	Far Advance	Comments
D15	Bridge Weight Limit	T					
D15	Except Combination	T					
D14	One Truck at a Time	Yes / No					
B22/B23	Vert. Clearance - On						See Sketch
B22/B23	Vert. Clearance - Und						See Sketch
	One Lane Bridge	Yes / No	(Opt)			(Opt)	
	Narrow Bridge	Yes / No	(Opt)			(Opt)	
	Hazard Clearance	Yes / No					
	Other						
(Opt)	Other						

Key --> OK: Signs properly installed M : Signs missing D : Signs damaged / incorrect New Wearing Surface Under Bridge: YES ☐ NO ☐

Notes ___

Vert. Clear. Sign **On Feature:** B01 = ___ B31 = ___ **Under Feature:** B01 = ___ B31 = ___

E26 Underclearance Appraisal ___ Controlling: Lateral ___ Vertical ___

E28-A Traffic Safety Features (Subfields shown vertically) Posted Speed Limit ___ mph

___ Bridge Railing

___ Transition

___ Approach Guiderail

___ Approach Rail Ends

E28 Approach Alignment ___

E15 Approach Roadway ___

Pavement ___

Drainage ___

Shoulders ___

E14 Approach Slab ___

Bump at Bridge Yes ☐ No ☐

C19 Relief Joint ___

SITE DATA Sheet______of______

Figure 4.3.15 Example Inspection Form – PADOT Form D-450

PDT Form D-450B **Bridge 1 Data** Inspection Date

(DEC 1996) A01 E06

For Non-State Roadways B01 B27 B28 B30A

Ref ADT ADT YR ADTT %

For State highways, data from RMS will be used.

E25 Deck Geometry Table Controlling Values: B27 / B34 / B22 A31 / A31 / B18

Design Exception granted ?

E16 Deck Wearing Surface

C10 Wearing Surface Type C10A Wearing Surface Thickness

E17 Deck Estimated Spall or Delamination % Est. Chloride Content

Top

Underside

Exp Joint No. C22 Exp Jt Types

Deck Drainage

E18 Superstructure See Sheet for Additional Details. Form 491-J attached for FCM details Yes/No

Girders / Beams

Floorbeams

Stringers

Diaphrams

Truss Members

Portals / Bracing

Bearings

Drainage System (Below Deck)

BRIDGE 1 DATA Sheet________of________

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450C (DEC 1996)

Abutment Data

A01

Inspection Date E06

E20 Substructure — Details on Sheet

NAB - Near Abutment (Use same notation as W09)

Backwall

Bridge Seats

Cheekwalls

Stem

Wings

Footing

Piles

Scour / Undermine Yes No See Details on Form Sheet

Settlement

Embank-Slope-Wall

Wall Drainage

FAB - Far Abutment (Use same notation as W09)

Backwall

Bridge Seats

Cheekwalls

Stem

Wings

Footing

Piles

Scour / Undermine Yes No See Details on Form Sheet

Settlement

Embank-Slope-Wall

Wall Drainage

ABUTMENT DATA Sheet of

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450D **Pier Data**
(DEC 1996) A01 | Inspection Date E06

Substructure (Cont.)

Pier / Bent Number ________ (Use same notation as W09)

Bridge Seats ________

Caps ________

Cheekwalls ________

Columns/Stems ________

Footings ________

Piles ________

Scour / Undermine Yes ☐ No ☐ See Details on Form ________ Sheet ________

Settlement ________

Pier / Bent Number ________ (Use same notation as W09)

Bridge Seats ________

Caps ________

Cheekwalls ________

Columns/Stems ________

Footings ________

Piles ________

Scour / Undermine Yes ☐ No ☐ See Details on Form ________ Sheet ________

Settlement ________

PIER DATA Sheet________of________

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450E (DEC 1996) **Waterway 1 Data** **BRIDGE MANAGEMENT SYSTEM** BRIDGE INSPECTION REPORT

BMS Updated b ______ Date ______

A01 | U.W. Inspection Date W01-A

Over ______ Weather Conditions ______

Inspection Type W02 | U.W. Inspection Type W02-A | Regular U.W. Insp. Freq. W03 | Interim U.W. Inps. Freq. W04 | Time started ______ Time completed ______

Name of Consultant and/or Inspectors W16 | Hired by W17 | Inspection Cost W15

E29A Scour Critical Rating W06 based on: ☐ Observed Scour ☐ Scour Calculation | No. of Units Inspected W14

Streambed Material W07 (36 SPACES)

E21 Channel/Channel Protection - Cond. Rating ☐ Details on Sheet ______

Channel ______

Banks ______

Streambed Movements ______

Debris, Vegetation ______

River (Stream) Control Devices ______

Embankment / Streambed Controls ______

Drift, Other ______

E27 Waterway Adequacy ☐ ______

Risk of Overtopping ☐ Remote ☐ Slight ☐ Occasional ☐ Frequent

Traffic Delay ☐ Insignificant ☐ Significant ☐ Severe **B18 - Functional Class.** ______

High Water Mark: ELEV : ______ DATE (mmyyyy) ______ ☐ New HW Mark ☐ HW since last inspecion

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings: ______

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings: ______

WATERWAY 1 DATA Sheet______of______

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

Form D-450F
(DEC 1996)

Waterway 2 Data

U.W. Inspection Date

A01 | W01-A

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

W09	W10	W11	W11-A	W11-B	W11-C	W11-F
Substructure Unit	Foundation Type	Water Depth	Observed Scour Rating	U.W. Insp Performed	Observed Depth	Counter-Measures

Findings:

WATERWAY 2 DATA Sheet________of________

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450G **Waterway 3 Data**

(DEC 1996) U.W. Inspection Date

A01 | | | | | W01-A |

OBSERVED SCOUR RATING GUIDE

Rating	ITEM NUMBER								Rating
	1	2	3	4	5	6	7	8	
	Change Since Last Inspection	Scour Hole	Debris Potential	Substructure Scourability	Opening Adequacy/ Channel	Sediment	Alignment	Velocity/ Stream Slope	
9	None	None	None	NF/P9/R9	Good	None	Good	Low	9
8	None	Minor	None	P8/C8/R8	Good	Minor	Good	Low	8
7	Minor	Minor	Minor	7/C7/R7	Fair	Minor	Good	Medium	7
6	Minor	Advanced	Medium*	A6	Fair	Medium	Medium	Medium	6
5	Medium*	Advanced	High*	A5	Fair	High	Medium	High	5
4	Medium	Serious*	High	R4*/A4*	Poor*	High	Poor*+	High	4
3	High*	Serious*	Present*	A3	Overtop*	High	Poor	High	3
2	Bridge is scour critical, IMMEDIATE action is required *								2
1	Bridge is scour critical, bridge is CLOSED *								1
0	Bridge has failed due to scour *								0

NOTES:

Rating considerations given in highest to lowest level of importance from left to right.

* If an item is so marked, it cannot be given a higher ranking.

founded on competent rock and no problems exist.

C = Effective Countermeasures

P = Pile Supported Substructures

DETERMINATION OF RATING FOR BMS ITEM W11-A

Substructure Unit	1	2	3	4	5	6	7	8	W11-A
	Change Since Last Inspection	Scour Hole	Debris Potential	Scourability	Opening Adequacy/ Channel	Sediment	Alignment	Velocity/ Stream Slope	Overall Observed Scour Rating

<u>If Underwater Inspection only</u>

Signatures and Date:

WATERWAY 3 DATA Sheet________of________

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450H (DEC 1996) **Culvert Data** A01 | Inspection Date E06

For Non-State Roadways: B01 Ref | B27 ADT | B28 ADT YR | B30-A ADTT %

For State highways, data from RMS will be used.

E25 Deck Geometry | Table | Controlling Values: B27 / B34 / B22 | A31 / A31 / B18

Design Exception granted ?

E16 Dk. Wearing Surf. | C10 W. Surface Type | C10A W. Surf. Thick.

E22 Culverts Condition Rating | Details on Sheet | C06 Culvert Length

Top Slab

Barrel

Floor / Paving

Headwall

Wings

Settlement

Debris

Re-calculate IR/OR: Yes | Due to: Deterioration | New Wearing Surf. | Other

No | Previous Rating Dated ______ is still valid

E30 Inventory Rating

E31 Operating Rating

H | HS | ML-80 | Other | Other | HS Load Factor

E32 Rate Meth | E33 Typ Mem | AASHTO | E37 Spec | E38 Manual

E29 Bridge Post | CONTROLLING: H | HS | ML80 | Engineering Judgement

E24 Structural Condition Appraisal | Based upon | Table 1 | B27-ADT | B30-IR

or | E18-Super | E20-Sub , | E22-Culvert

E01 Next Insp. Freq. | E03 Equip. Next Insp.

E04 Spec. Insp. Type | E05 By Date | E23 Remaining Life

Is culvert over water? | Yes. Complete Forms D-450E through G | E17 = N | E18 = N | E20 = N

No. | E21 = N | E27 = N | E29A = N | E17 = N | E18 = N | E20 = N

Signatures and Date:

CULVERT DATA Sheet of

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450K **Bridge 2 Data**
(DEC 1996) A01 Inspection Date E06

E19 Paint Condition New Paint Y / N If Yes: Spot Zone Full Revise item G08-G17

Interior Beam / Girder

Fascias

Splash Zone: Truss / Girder

Truss

Bearings

Other

E23 Est. Remaining Life BMS to Calculate Yes/No Comments

Recalculate IR/OR: Yes Due to: Deterioration New Wearing Surf. Other
No Previous Rating Dated ______ is still valid

E30 Inventory Rating

E31 Operating Rating

H HS ML-80 Other Other HS Load Factor

E32 Rate Meth E33 Typ Mem AASHTO E37 Spec E38 Manual

E29 Bridge Post CONTROLLING: H ______ HS ______ ML80 ______ Engineering Judgement ______

E24 Structural Condition Appraisal Based upon Table 1 B27-ADT ______ B30-IR ______
or E18-Super ______ E20-Sub ______, E22-Culvert ______,

E01 Next Insp. Freq. E03 Equip. Next Insp.

E04 Spec. Insp. Type E05 By Date

Is bridge over water? Yes. E22 = N Complete Forms D-450E through G
No. E22 = N E21 = N E27 = N E29A = N

Notes:

Signatures and Date:

BRIDGE 2 DATA Sheet______of______

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

PDT Form D-450M **Maintenance Needs Data** Inspection Date

(DEC 1996) A01 E06

Approach Roadway Work	H01 Item #	H03 Location		H05 Quantity	H08 PR	H09 D/C
Pavement (Patch/Raise)	RDPAVMT	L N R L F R	SY			
Pavement Relief Jt (Rep/Repl)	RDRLFJT	L N R L F R	SY			
Shoulders (Repair/Reconstr)	RDSHLDR	L N R L F R	SY			
Drainage-Off Bridge (Improve)	RDDRAIN	L N R L F R	EA			
GR/Trans/End (Rep/Repl/Imp)	RDGDERL	L N R L F R	EA			
Load Limit Signs (Replace)	RDLDSGN	L N R L F R	EA			
Clearance Signs (Replace)	RDCLSGN	L N R L F R	EA			
Cut Brush to Clear Signs	RDBRUSH	L N R L F R	EA			
Approach Slab (Replace)	A744201	L N R L F R	SY			
Cleaning - Flushing						
Deck	A743101	-- --	EB			
Scupper/Down Spouting	B743101	1 2 3 4 5 O	EB			
Bearing/Bearing Seat	C743102	1 2 3 4 5 O	EB			
Steel-Horizontal Surfaces	D743102	1 2 3 4 5 O	EB			
Deck						
Bitum Deck W Surf (Rep/Repl)	BITWRGS	1 2 3 4 5 O	SY			
Timber Deck (Rep/Repl)	B744301	1 2 3 4 5 O	SY			
Open Steel Grid (Rep/Repl)	C744302	1 2 3 4 5 O	SY			
Concrete Deck (Repair)	D744303	1 2 3 4 5 O	SY			
Concrete Sidewalk (Repair)	E744303	1 2 3 4 5 O	SY			
Concrete Curb/Parapet (Rep)	F744303	1 2 3 4 5 O	SY			
Deck Joints - Expansion Joints						
Reseal	A743301	N 1 2 3 O F	LF			
Repair/Reseal	A744101	N 1 2 3 O F	LF			
Compression Seal (Rep/Rehab)	B744102	N 1 2 3 O F	LF			
Modular Dam (Rep/Rehab)	C744102	N 1 2 3 O F	LF			
Steel Dams (Rep/Rehab)	D744102	N 1 2 3 O F	LF			
Other Types (Rep/Rehab)	E744102	N 1 2 3 O F	LF			
Bridge Railings - Parapets						
Bridge Parapet (Rep/Repl)	RLGBRPR	N 1 2 3 O F	LF			
Struct Mount GR (Rep/Repl)	RLGSTRM	N 1 2 3 O F	LF			
Pedestrian (Rep/Repl)	RLGPEDN	N 1 2 3 O F	LF			
Median Barrier (Rep/Repl)	RLGMEDB	1 2 3 4 5 O	LF			
Deck Drainage						
Scupper Grate (Replace)	DRNGRAT	1 2 3 4 5 O	EA			
Drain/Scupper (Install)	B744401	1 2 3 4 5 O	EA			
Downspouting (Rep/Repl)	C744402	N 1 2 3 O F	EA			
Bearings						
Lubricate	A743501	N 1 2 3 O F	EA			
Steel (Rep/Rehab)	A744501	N 1 2 3 O F	EA			
Steel (Replace)	B744501	N 1 2 3 O F	EA			
Expansion (Reset)	C744502	N 1 2 3 O F	EA			
Pedestal/Seat (Reconstruct)	D744503	N 1 2 3 O F	EA			
Timber						
Stringer (Rep/Repl)	A744601	1 2 3 4 5 O	EA			
Other Members (Rep/Repl)	B744601	1 2 3 4 5 O	EA			

Steel	H01 Item #	H03 Location		H05 Quantity	H0 PR	H09 D/C
Stringer (Rep/Repl)	A744602	1 2 3 4 5 O	EA			
Floorbeam (Rep/Repl)	B744602	1 2 3 4 5 O	EA			
Girder (Repair)	C744602	1 2 3 4 5 O	EA			
Diaph/Lat. Bracing (Rep/Repl)	D744602	1 2 3 4 5 O	EA			
Reinforced, PS, PC, and PT Concrete						
Stringer (Rep/Repl)	A744603	1 2 3 4 5 O	EA			
Diaphragm (Rep/Repl)	B744603	1 2 3 4 5 O	EA			
Other Members (Rep/Repl)	C744603	1 2 3 4 5 O	EA			
Truss						
Members (Strengthen/Rep/Repl)	A744701	1 2 3 4 5 O	EA			
Portal (Modify)	B744701	1 2 3 4 5 O	EA			
Members(Tighten/Flameshorten)	C744702	1 2 3 4 5 O	EA			
Painting						
Superstructure - Spot	A743201	1 2 3 4 5 O	EB			
Substructure - Spot	B743201	N 1 2 3 O F	EB			
Superstructure - Full	C743201	1 2 3 4 5 O	EB			
Substructure - Full	D743201	N 1 2 3 O F	EB			
Abutment - Wings - Piers						
Backwall (Rep/Repl)	A744801	L N R L F R	CY			
Abutments (Repair)	B744802	L N R L F R	CY			
Wing (Rep/Repl)	C744802	L N R L F R	CY			
Piers (Repair)	D744802	1 2 3 4 5 O	CY			
Footing (Underpin)	E744803	N 1 2 3 O F	CY			
Masonry (Repoint)	F744804	N 1 2 3 O F	LF			
Abut Slopewall (Rep/Repl)	A745101	L N R L F R	SY			
Abut Slopewall (Construct New)	B745102	L N R L F R	CY			
Pile Repair	A745901	N 1 2 3 O F	EA			
Scour - Erosion Control						
Streambed Paving (Rep/Constr)	A745301	UP UN DN	CY			
Rock Protection	B745301	UP UN DN	CY			
Scour Hole (Backfill)	C745301	UP UN DN	CY			
Stream Deflector (Rep/Constr)	D745302	UP UN DN	CY			
Vegetation/Debris (Remove)	ECREMVG	UP UN DN	CY			
Deposition (Remove)	ECREMDP	UP UN DN	CY			
Culvert						
Headwall/Wings (Rep/Repl)	A745201	IN OUT	SY			
Apron/Cutoff Wall (Rep/Repl)	B745202	IN OUT	SY			
Barrel (Repair)	C745203	-- --	SY			
FOR COMPLETION BY REVIEW ENGINEER						
Apply Protective Coating						
Deck/Parapet/Sidewalk	A743401	DK PARA SW	SY			
Substructure	B743401	N 1 2 3 O F	SY			
Construct Temporary						
Support Pier	A745401	N 1 2 3 O F	EA			
Pipe/Culvert Crossing	B745401	LT CL RT	EB			
Bridge	C745401	LT CL RT	EB			

REP....... Repair
N............ Near
F............ Far
O............ Other
IN........... Inlet
REPL...... Replace
UP.......... Upstream
DN.......... Downstream
UN.......... Under
OUT ...... Outlet
IMP............ Improve
LNR............ Near Left/Right
LFR............ Far Left/Right
1,2,3, etc...... Span/Pier No.
EB.............. Each Bridge (site)

PR - PRIORITY CODE
0 - Prompt action required. (Inform Bridge Engineer before updating BMS)
1 - High Priority, as soon as work can be scheduled.
2 - Priority, review work plan, adjust schedule if needed.
3 - Add to scheduled work.
4 - Routine structural, can be delayed until funds are available.
5 - Routine non-structural, can be delayed until programmed.

MAJOR IMPROVEMENT NEEDS

F01 **Year Needed** F04 **Improvement Length**

F02 **Type Work** F06 **Bridge Width**

F10 **Future ADT** F11 **Future ADT Year**

Reviewed On: ________

By: ________

MAINTENANCE NEEDS DATA Sheet________of________

Figure 4.3.15 Example Inspection Form – PADOT Form D-450 (continued)

Michigan Department of Transportation

BRIDGE INSPECTION REPORT

03032-B03

Bridge Number	Inspector Name	Insp Key	Pontis ID
Facility Carried			Region
Feature Intersected			Inspection Date Old New
Location			

PONTIS BRIDGE INSPECTION **English Units**

Element Number	Element Name	Total Quant	State 1		State 2		State 3		State 4		State 5	
			Old	New	Old	New	Old	New	Old	New	Old	New

CREW RECOMMENDATIONS

Deck Patching		
Approach Pavement		
Joint Repair		
Railing Repair		
Detailed Insp		
Zone Paint		
Substr. Repair		
Slope Repair		
Brush Cut		
Other Crew Work		

CONTRACT RECOMMENDATIONS

Bridge Replacement		
Superstructure Replacement		
Deck Replacement		
Overlay		
Widen		
Paint		
Zone Paint		
Pin and Hanger		
Substructure Repair		
Other Contract Work		

Note: This form is for use on site only, not to be submitted

Figure 4.3.16 Core Element Example Inspection Form – Michigan Department of Transportation

4.3.4 Documenting Elements Using Proper Nomenclature

Element Identification

Elements should be identified by the type of material, construction method, and by the function that each element performs.

Some material types and construction methods employed include:

- Timber
  - Solid sawn
  - Laminated
- Concrete
  - Cast-in-place: voided or solid
  - Precast: regular reinforcement or prestressed
- Steel
  - Rolled
  - Welded
  - Riveted
  - Bolted

Some examples of element functions and the abbreviations used with them are:

- Multi-beam (B1 – B6)
- Deck slab
- Stringer (S1 – S4)
- Floorbeam (FB0 – FB15)
- Girder (G1, G2)
- Truss chord (U0U1 – U.S.)
- Truss diagonal (U0L2 – D.S.)
- Secondary bracing (Top Lat. Br. U0 U.S. to U1 D.S.)
- Arch
- Spandrel column (Col. 1 – Col. 14)
- Spandrel wall (U.S., D.S. or N, S, E, W)
- Abutment (Abut. 1, Abut. 2)
- Pier (P1 – P4)

Element Orientation

Structure orientation is normally established according to highway direction of inventory, mile markers, or stationing. It is important that the orientation of each element be clearly established. The following are some examples:

- Number the substructure units (e.g., Abutment 1 and Pier 3)
- Identify sides of floorbeams with near/far (e.g., north/south or east/west) designations.
- Sides of members can be identified by direction (e.g., "south side of Floorbeam 2" or "northeast elevation of Beam 4").
- Span numbers and bay numbers should be used to identify general areas

on the bridge (see Figure 4.3.17).

- Individual beams or stringers should be numbered left to right, looking in the direction of inventory (see Figure 4.3.18).
- Upstream or downstream designations can be assigned to structures over waterways (e.g., "upstream truss," "downstream girder," or "upstream arch") (see Figure 4.3.19).
- For truss elements, identify the member with joint designations (see Figure 4.3.20). Number floorbeams in accordance with the panel point numbers.

If the orientation used during the inspection differs in any way with that used in existing documents, these differences should be clearly stated in the inspection notebook.

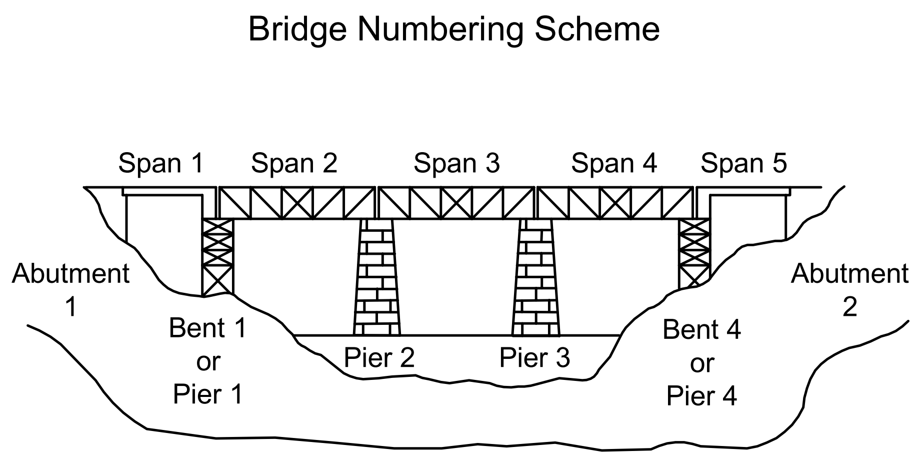


Figure 4.3.17 Sample Span Numbering Scheme

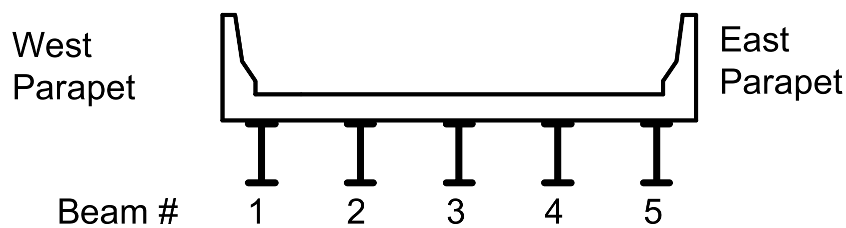


Figure 4.3.18 Sample Typical Section Numbering Scheme

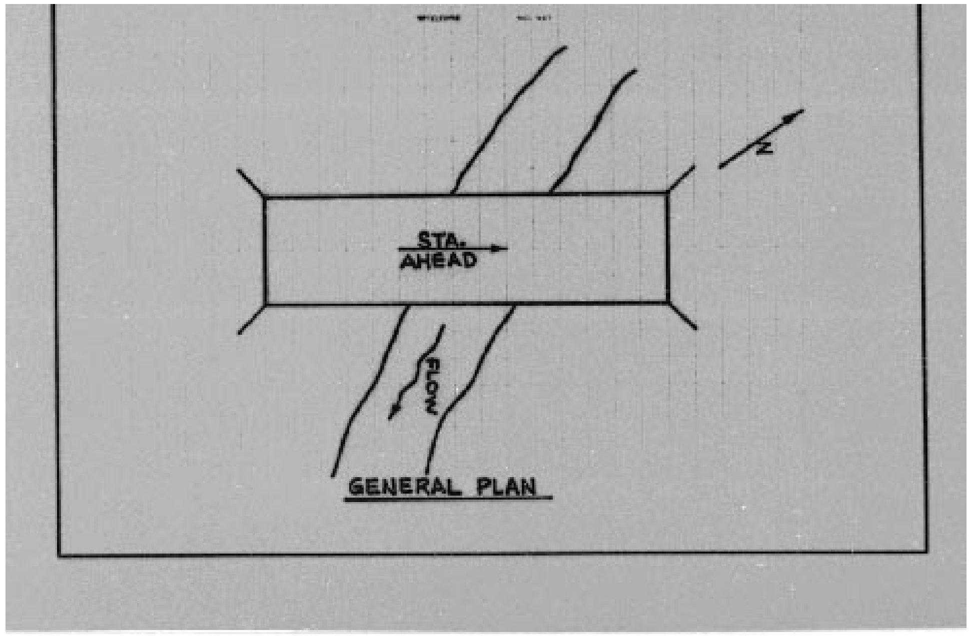


Figure 4.3.19 Sample Structure Orientation Sketch

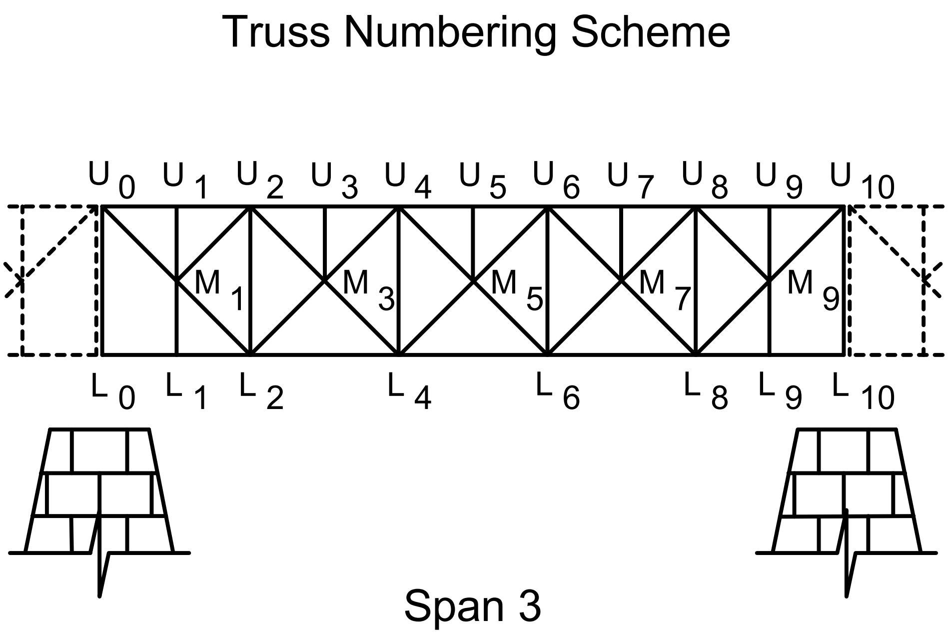


Figure 4.3.20 Sample Truss Numbering Scheme

Element Dimensions

Sufficient dimensions must be documented to establish the cross section and other pertinent dimensions of elements. These should include:

- Deck sizes – length, width, and depth
- Beam, girder, floorbeam, stringer, and truss member sizes - length, width, and depth of each; spacing and span length (see Figures 4.3.21 and 4.3.22)
- Abutment and columns - width and depth (for rectangular shapes), diameter (for round columns), length, spacing, and pile batter and spacing

(for pile bents)

- Caps and struts - width, depth, clear span, and cantilever span

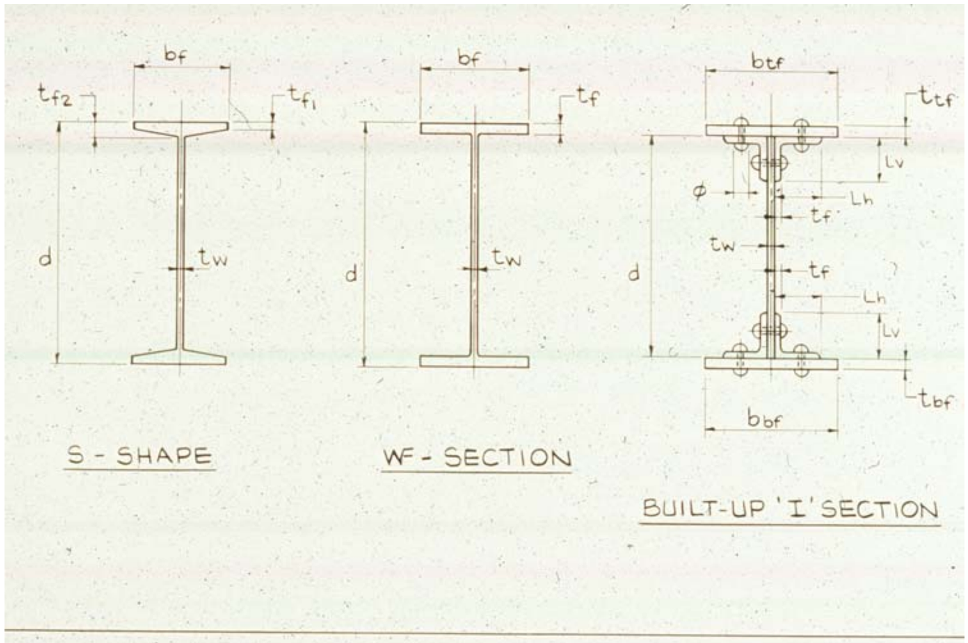


Figure 4.3.21 Steel Beam and Girder Dimensions

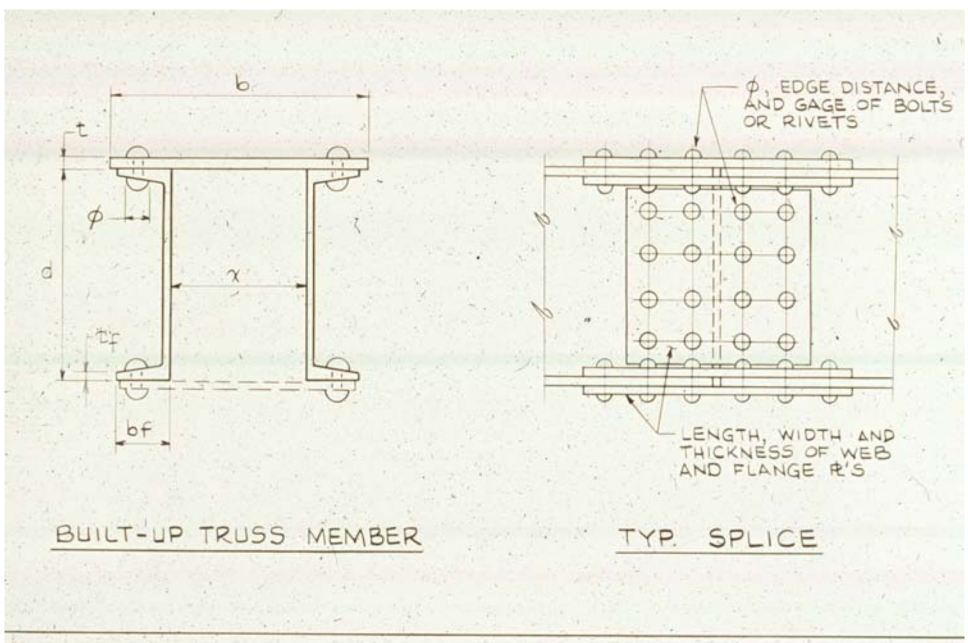


Figure 4.3.22 Truss Member and Field Splice Dimensions

4.3.5 Documenting Defects Using Proper Nomenclature

Defect Identification

Defects should be identified by their specific types.

Defects that are likely to occur in timber elements include:

- Decay - caused by either fungi or insects
- Checks - partial depth
- Splits - full depth
- Knots
- Shakes
- Wear - caused by traffic or water
- Fire damage
- Delamination of glulam beams
- Weathering
- Collision damage
- Warping

Typical concrete defects to look for include:

- Delaminations
- Spalls
- Scaling
- Cracks (structural or nonstructural)
- Exposed rebar or strands
- Corrosion or section loss to rebar or strands
- Camber (for prestressed beams)
- Chloride contamination
- Efflorescence
- Collision damage

Some of the defects that may be encountered on steel and iron elements include:

- Corrosion and section loss
- Cracks
- Deformation
- Buckling
- Fire damage
- Paint failures
- Collision damage

Defect Qualification

Documenting of defects by the inspector must describe the seriousness of a defect. For example:

- Crack sizes - record lengths, widths, and depth
- Section loss - record the remaining section dimensions (when reporting section loss, it is important to document the section remaining rather than

trying to estimate the percentage of section loss)

- Deformation - record amount of misalignment

Defect Quantification

The inspector must also describe the quantity of a defect. For example:

- Spalling – 2’ x 3’ x 2” deep
- Scaling – 4’ high by full abutment width
- Delamination – 1’ x 6”
- Decay – 2’ x 2’ x 3” deep

Defect Location

The exact position of the defect on the element or member is required if load capacity analysis is to be performed. For example:

- Left side of web, top half, 3 feet from north bearing
- Top of top flange, from 3 feet to 6 feet west of Pier 2

The accuracy of the load capacity analysis depends on precise location information for defects:

- Bending moment – Flexure is maximum at or near midspan for simple span structures. Maximum negative moment occurs at the intermediate supports if the structure is continuous.

- Shear – Shear is maximum at or near the supports.

- Axial compression members - The capacity of the member to resist compressive forces is reduced by any deformation or change in cross section. The potential capacity reduction is not dependent on where on the member the defect is located. All segments are critical.

- Axial tension members - These members experience a reduction in capacity through loss of section or from cracking. As with the axial compressive members, tensile members are equally susceptible regardless of the location of the defect.

- Combinations - While axial members are critical at all locations, it is not always apparent which members are loaded only in an axial direction. In fact, due to the dead load of the member itself, most are not. Other factors can also contribute to bending forces that will create varying moments, shears, compression, and tension areas within a member that is primarily axial. Because of this, inspectors should identify the exact position of defects in all members using reference points, regardless of the forces acting on the member.

Locating a defect may include tying it to an established permanent reference. Avoid using references that can change over time.

Some examples of proper referencing include:

- 2210 mm (7’-3”) from fixed bearing on Beam 3 at Abutment 1
- 940 mm (3’-1”) from west corner of Abutment 2
- 760 mm (2’-6”) below bridge seat on south face of Column 1, Pier 2

Reference points to avoid:

- Expansion rocker faces
- Ground levels, especially those that may be exposed to water
- Water levels

4.3.6 Structure Files

Structure files are used to maintain detailed information on each important structure. A thorough study of the available historical information can be extremely valuable in identifying possible critical areas of structural or hydraulic components and features. Because this information may require considerable effort to assemble, a separate file should be established for each structure.

The contents of any particular file may vary depending upon the size and age of the structure, the functional classification of the road carried by the structure, and the informational needs of the agencies responsible for inspection and maintenance. A very small structure may be documented in an inventory listing or with a file that contains little more than an inventory card plus dates and comments of previous inspections. For larger structures, it is recommended that the following types of information be assembled when possible.

Construction and Design

"As built" or design plans should be included in a structure file. If plans are not available, the following types of construction information should be determined: date built; type of structure, including size, shape, and material; design capacity; and design service life. Hydraulic data should also be assembled where available, including slope of structure, elevation of inverts or footings, stream channel and water surface during normal and high flows, design storm frequency, drainage area, design discharge, date of design policy, flow conditions, limits of flood plain, type of energy dissipaters (if present), cut-off wall depth, channel alignment, and channel protection.

Repair History

Information about repairs and rehabilitation activities should be collected. The types and amount of repairs performed at a bridge or culvert site can be extremely important. Frequent roadway patching due to recurring settlement over a culvert or approach roadway for a bridge may indicate serious problems that are not readily apparent through a visual inspection of the structure itself.

Inspection History

Data from previous inspections can be particularly useful in identifying specific locations that require special attention during an inspection. Information from earlier inspections can be compared against current conditions to estimate rates of deterioration and to help judge the seriousness of the problems detected and the anticipated remaining life of the structure.

This page intentionally left blank

Table of Contents

Section 4

Bridge Inspection Reporting System

Topic 4.4 The Inspection Report

4.4.1 Introduction

The purpose of the bridge inspection reporting system is to have trained and experienced personnel record objective observations of all elements of a bridge and to make logical deductions and conclusions from their observations.

The bridge inspection report should represent a systematic inventory of the current or existing condition of all bridge members and their possible future weaknesses. Moreover, bridge reports form the basis of quantifying the manpower, equipment, materials, and funds that are necessary to maintain the integrity of the structure.

A bridge inspection is not complete until an inspection report is finalized. The bridge inspection report must document all signs of distress and deterioration with sufficient precision so that future inspectors can readily make a comparison of condition. A complete inspection report contains several parts, as outlined in this topic. A sample bridge inspection report is presented in Appendix B. An inspection report should be prepared for special inspections, which are conducted for checking a specific item where a problem or change may be anticipated. Even if no changes are evident, a report should be made for each type of bridge inspection, even if it may only be a cursory inspection. Some bridge owners also request a special bridge inspection and report when planning a major rehabilitation.

4.4.2 Basic Components of a Comprehensive Bridge Inspection Report

Table of Contents

The table of contents should present the general headings and topics of the inspection report in an orderly manner so that individual sections of the report can be found with ease. It generally follows the title page, and individual sections are listed with their corresponding starting page number.

Location Map

A map should be included with a scale large enough to positively locate the structure. The bridge should be clearly marked and labeled, and the map should have a north arrow.

Bridge Description and History

The bridge description and history section of the report should contain all pertinent data concerning the design, construction, and use of the bridge. The type of superstructure will generally be given first, followed by the type of abutments and piers, along with their foundations. If data is available, indicate the type of foundation soil, maximum bearing pressures, and pile capacities. The type of deck is also indicated.

Design Data

The design information should include a description of the following:

- Skew angle
- Number and length of spans
- Total length
- Bridge width
- Wearing surface
- Sidewalks
- Railing
- Year constructed/reconstructed
- Number of traffic lanes
- Design live loading
- Waterway
- Other features intersected
- Clearances
- Encroachments
- Alignment

Construction Data

The construction history of the bridge should include the date it was originally built, as well as the dates and descriptions of any repairs or reconstruction projects. State what plans are available, where they are filed, and whether they are "as-built."

Service Data

State the average daily traffic (ADT) count and the average daily truck traffic (ADTT) count, along with the date of record. This information should be updated approximately every five years. Any environmental conditions which may have an effect on the bridge, such as salt spray, industrial gases, bird droppings, and ship and railroad traffic, should be noted in the report.

The history of the bridge is from a structural standpoint and should be developed from information obtained from design, construction and rehab plans, previous inspection reports, maintenance records, discussions with maintenance crews and local residents, and any other available source that offers pertinent information. Items to be included in the history narrative include:

- Year built
- Reconstruction year, if any
- Historical flood frequencies and high water marks
- Maintenance measures and repairs
- Chronological record of conditions
- Reference drawings
- Photos

Executive Summary

The executive summary is a narrative presentation summarizing the inspection and analysis findings in regard to the qualitative condition and the load capacity of the bridge, along with an overview of recommendations. The executive summary must properly identify the bridge (e.g., name, number, and location) and the date of inspection. The executive summary should also present any high priority repair items.

Inspection Procedures

The procedures and equipment used to inspect the bridge should be documented. In most instances, it is advantageous to inspect structures in the same sequence as the load path (i.e., the deck first, then the superstructure, and finally the substructure). This manual is organized and presented in that sequence.

However, many inspections cannot follow this sequence due to traffic and lane-closure restrictions. It is useful to document whatever sequence was used during the inspection. This information will be useful in planning future inspections and will also serve as a checklist to make sure that all elements and components were inspected. The following information should be included:

- Equipment required (e.g., hammers and plumb bobs)
- Access equipment (e.g., rigging, ladders, and free climbing)
- Access vehicles (e.g., inspection cranes and bucket trucks)
- Traffic restrictions (e.g., lane closures, flagmen, and hours of operation)
- Inspection methods (e.g., corings and ultrasonic)
- Personnel (e.g., by name and classification)
- Special equipment (e.g., material testing and underwater inspection)
- Deviations from "hands-on" inspection of all areas
- Time required for inspection
- Channel profiles

When structure plans are not on file and a load rating has not been calculated, it may be necessary to obtain field measurements to permit calculation of the load capacity of the structure.

Inspection Results

Narrative descriptions of the conditions should be both quantitative and qualitative, indicating the locations and the extent of the affected areas. Use forms consistent with similar inspections. Note all signs of distress, failure, or defects with sufficient precision so that a deterioration rate can be determined. This is very important for determining estimated remaining life and an optimal improvement stategy.

Note any load, speed, or traffic restrictions on the bridge. Include information about high water marks and unusual loadings. Note the environmental conditions such as temperature, rain, or snow. All work or repairs to the bridge since the last inspection should be listed. Verify or obtain new dimensions when improvement work has altered the dimensions of the structure. New streambed profiles should be taken with each inspection to detect scour, channel migration, or channel aggredation and degradation.

The seriousness and amount of all deficiencies must be clearly stated. In emergency situations, the inspector should immediately contact the inspection supervisor and the representative of the bridge owner.

Load Rating Summary

A summary of any load capacity rating analysis that has been performed should be included in the report. The summary should be presented in a table or chart. Governing load ratings should be shown for both inventory and operating levels for all types of loadings used in the analysis. The governing member for each rating should be identified. The governing member is the one that has the lowest capacity for a given type of loading.

For example, in a Girder-Floorbeam-Stringer structure, Stringer 3 in Bay 5 may have the lowest capacity for carrying HS20 trucks, compared to all other stringers, floorbeams, or girders. The HS20 inventory and operating ratings for this stringer would be reported, and it would be identified as the governing member.

Conclusions and

A good inspection report should explain in detail the type and extent of any

Recommendations

deterioration found on the bridge and should point out any deviations or modifications that are contrary to the "as-built" construction plans. The depth of the report should be consistent with the importance of the deterioration. Not all conditions of deterioration are of equal importance. For example, a crack in a prestressed concrete box beam which allows water to enter the beam is much more serious than a vertical crack in an abutment backwall or a spall in a corner of a slopewall.

The inspector, in formulating conclusions for the cause of the defect, must report the seriousness of the defect or deficiency involved. The inspector's experience and judgment are called upon when interpreting inspection results and arriving at reasonable and practical conclusions. The conclusions are the heart of the inspection report. Improper and misinformed conclusions will lead to improper recommendations. The inspector may need to play the role of a detective to conclude why, how, or when certain defects occurred. When the inspector cannot interpret the inspection findings, the advice of more experienced personnel should be sought.

The recommendations made by the inspector constitute the "focal point" of the operation of inspecting, recording, and reporting. The inspector must review previous inspection recommendations and identify any that have not been addressed, particularly if urgent. A thorough, well documented inspection is essential for making informed and practical recommendations to correct or preclude bridge defects or deficiencies.

All recommendations for maintenance work, stress analysis, postings, further inspection, and repairs should be included. The inspector must carefully consider the benefits to be derived from making repairs and the consequences if the suggested repairs are not made. The inspector should list, in order of greatest urgency, any repairs that are necessary to maintain structural integrity and public safety. Recommendations concerning repairs may be classified into two general categories:

- Urgent repairs
- Programmed repairs (i.e., those to be performed sometime later)

The inspector must decide whether a repair is urgent. Usually this is easily determined, but occasionally the experience and judgment of a Professional Engineer may be required to reach a proper decision. A large hole through the deck of a bridge obviously needs attention, and a recommendation for emergency repair is in order. By contrast, a slightly deteriorated gusset plate at a panel point of a truss may not be critical. A condition such as this would appropriately call for a recommendation for a programmed repair.

Typically, most recommendations concerning repairs submitted by the bridge inspector will be in the category of programmed repairs (i.e., repairs that will be incorporated into preprogrammed repair and maintenance schedules). Whenever recommendations call for bridge repairs, the inspector must carefully describe the type of repairs that are needed, the scope of work to be done, and an estimate of the quantity of materials that will be required.

If not already described in the executive summary, the conclusions and recommendations section of the report should summarize the following:

- Overall condition
- Major deficiencies
- Load-carrying capacity
- Recommendations for:
  - Further inspection
  - Maintenance
  - Repairs
  - Painting
  - Posting
  - Rehabilitation
  - Replacement

Some state and local agencies designate separate personnel to prepare recommendations and cost estimates.

Report Appendices

The appendices should contain any back-up information that can be used to substantiate the inspector's conclusions and recommendations. As a minimum, the appendix should include photographs, drawings and sketches, and inspection forms. It can also include copies of any field notebooks used and specialist reports (e.g., underwater, nondestructive testing (NDT), and survey), or these documents can be referenced in the report.

Photographs

Photographs will be of great assistance to anyone reviewing reports on bridge structures. It is recommended that pictures be taken of any problem areas that cannot be completely explained by a narrative description. It is better to take several photographs that may be unessential than to omit one that would preclude misinterpretation or misunderstanding of the report. At least two photographs of every structure should be taken. One of these should depict the structure from the roadway, while the other photo should be a view of the side elevation. Also, photographs should be inserted on sheets that are the same size as the report pages. Captions should be provided for each photo, and photos should be numbered so that they can be referred to in the body of the report.

Drawings and Sketches

Sketches should be used freely as needed to illustrate and clarify conditions of structural elements. Clear diagrams are very helpful at future investigations in determining the progression of defects and to help determine any changes and their magnitude. Drafting-quality plans and sketches, sufficient to indicate the layout of the bridge, should be included as an appendix.

Inspection Forms

The inspection forms should contain the actual field notes, as well as the numerical condition and appraisal ratings by the inspector. The inspection forms must be signed by the inspection team leader. A complete SI&A form should be included in the appendix. If a previous report or printout is used for inventory data, items should be field checked for accuracy.

Load Capacity Analysis

Stress analysis is frequently performed on the structure to determine the load capacity of the bridge. It should include investigation of all primary load-carrying members of the bridge. Such analysis is normally performed by engineers in the office, not by the inspector. Also, not all inspections require stress analysis.

Field Inspection Notes

The original notes taken by the inspectors in the field or photocopies thereof should be included in the appendix section of the report. The original field notes are source documents and as such should be included in the structure file.

Underwater Inspection Report

If an underwater inspection of the substructure has been performed, a separate report is usually prepared by the diver. If applicable, the diver's report should be included in the appendix.

Material Testing Results

Sometimes material testing is performed on a structure in order to determine the strength and properties of an unknown or suspect material. The testing lab's report should also be included in the appendix of the bridge inspection report.

To achieve maximum effectiveness, each report should be supplemented with sketches, photographs, or any other additional explanatory information. Reports and supplemental information must be accurate, and descriptions or explanations should be clear and concise.

4.4.3 Importance of the Inspection Report

Source of Information

The bridge inspection report is an extremely valuable document when completed properly. A new inspection report should be made each time a bridge is inspected.

A well prepared report will not only provide information on existing bridge conditions, but it also becomes an excellent reference source for future inspections, comparative analyses, and bridge study projects. Any conditions that are suspicious but unclear should be reported in a factual manner, avoiding speculation. Further action on such reports will be determined after review and consultation by more experienced personnel.

Legal Document

In preparing a report, keep in mind that bridge funding may be allocated or repairs designed based on this information. Furthermore, the inspection report is a legal record which may form an important element in some future litigation. The language used in reports should be clear and concise and, in the interest of uniformity, care should be taken to avoid ambiguity of meaning. The information contained in reports is obtained from field investigations, supplemented by reference to "as-built" or "field checked" plans. The source of all information contained in a report should be clearly stated.

The inspector should sign and date the inspection forms and condition reports as they are completed. No undocumented alterations should be made to the report once it is completed. Some inspectors retain copies of their reports for their personal files in the interest of self-protection should any litigation come about.

Critical Areas

A primary purpose of the inspection report is to provide guidance for immediate follow-up inspections or action. The report provides information which may lead to decisions to limit the use of, or to close to traffic, any bridge which the inspection has revealed to be hazardous to public safety.

Maintenance

Another purpose of the inspection report is to provide useful information about the needs and effectiveness of routine maintenance activities. An active preservation program is vital to the long-term structural integrity of a bridge. The inspection report enables bridge maintenance to be programmed more effectively through early detection of structural defects or deficiencies, thus minimizing repair costs.

Load Rating Analysis

When an inspection reveals defects or deficiencies that may effect the load capacity of the structure, it should be reviewed by an engineer to determine if a revised stress analysis is needed. Any new stress analysis is made to determine the safe load capacity for the current condition. It may then be necessary to restrict loads crossing the bridge so that its safe load capacity is not exceeded. It is important that the calculations for the revised load-carrying capacity analysis become part of the structure file.

Bridge Management

Another purpose of the inspection report is analysis by the states and the FHWA of the SI&A data. The intent of the analysis is to aid in the decisions for allocating and prioritizing funding.

4.4.4 Quality

The accuracy and uniformity of information collected and recorded is vital for the management of a state's bridges for rehabilitation, maintenance, replacement, and, most importantly, public safety. Quality cannot be taken for granted. The responsibility of ensuring quality bridge inspections rests with each state or agency. The operation of a quality review will be determined by the organization of the inspection teams. Two phrases are frequently used when discussing quality: quality control and quality assurance.

Quality Control

Quality control (QC) is the establishment and enforcement, by a supervisor, of procedures that are intended to maintain the quality of the inspection at or above a specific level. If a state's inspection program is decentralized, the individual districts are responsible for their own QC. If the inspection efforts are centralized, then the responsibility for QC is at the centralized level.

Quality Assurance

Quality assurance (QA) is the verification of the level of quality of the bridge inspection. This is accomplished by the reinspection of a sample of bridges by an independent inspection team. For decentralized state inspections, the QA program can be performed by the central staff or their agent (e.g., consultants). If the inspections are centralized within the state, then the QA program should be performed by consultants or a division separate and independent of the inspection organization.

The quality of the inspection and reports rests primarily with the inspection team leaders and team members and their knowledge and professionalism in developing a quality product. A QA/QC program is a means by which random inspections, reviews, and evaluations are performed in order to provide feedback concerning the quality and uniformity of the state's or agency's inspection program. The feedback is then used to improve the inspection program through improved inspection processes and procedures, training, and quality of the inspection report.

Sample inspection report is located in the appendix.